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Topics

Papers will be accepted in the following categories:

(a) Plant systematics (Australian and horticultural groups); (b) Descriptive plant morphology, anatomy and ecology; (c) Obituaries, biography and history; (d) Bibliographic studies, book reviews; (e) Botanical illustrations; (f) Noteworthy horticultural contributions. Preference will be given to unpublished material of suitable standard not intended for publication elsewhere.

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Smith, L. L. (1879). The species of *Danthonia* found in pastures in Victoria. *Austral. J. Bot.* 65: 28-53.

Bentham, G. (1868). "Flora Australiensis", Vol. 4. (L. Reeve: London).

Baker, J.G. (1898). Liliaceae. In Thiselton-Dyer, W. T. (ed.). "Flora of Tropical Africa", Vol. 7. (L. Reeve: Ashford).

Journal abbreviations must be consistent within a paper and authors are recommended to follow "Botanico-Periodicum-Huntianum". Journals not cited in B-P-H should be abbreviated to conform with this general pattern. The following abbreviations for Australian states should be used: WA, NT, SA, Qld, NSW, ACT, Vic., Tas.

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Benth., *Fl. Austral.* 4: 111 (1868) OR

Benth., *Fl. Austral.* 4: (1868) 111.

Citation of specimens

10-30 specimens should be cited for each species (or subspecific taxon), although this may be varied under certain circumstances. The author may decide whether or not to include dates of collections and the sequence, provided a constant pattern is adhered to throughout a paper.

Authors wishing to cite all specimens seen may list them all in an index to collectors after the style of the "Flora Malesiana" identification lists. Collections not identifiable by a collection number (assigned by either the collector or herbarium) should cite dates.

Correspondence

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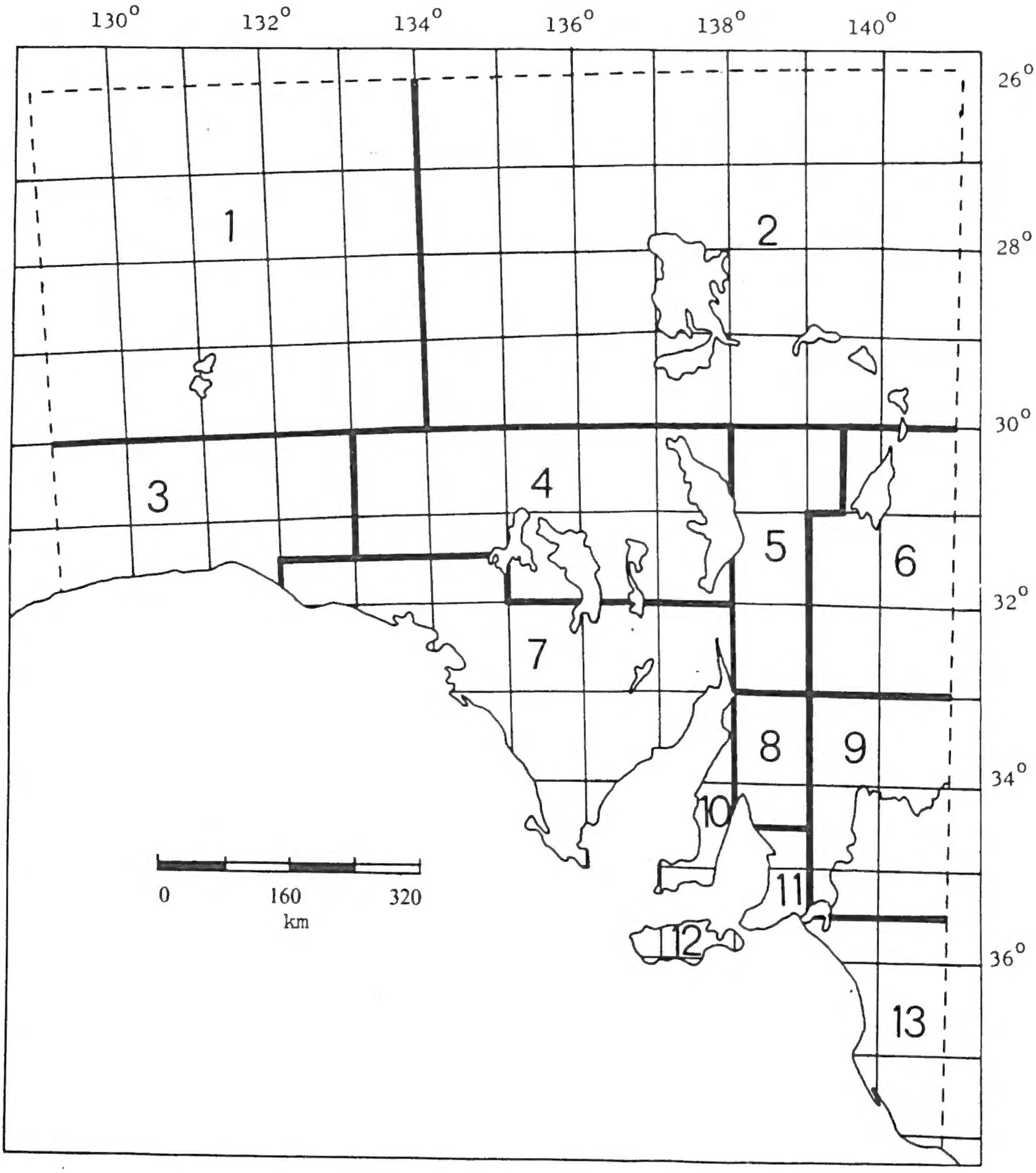

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A TAXONOMIC REVISION OF THE GENUS *DURANTA* L. (VERBENACEAE)* IN AUSTRALIA

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Abstract

A taxonomic revision of *Duranta* L. in Australia is presented. One naturalised species *D. erecta* (=*D. repens* and *D. plumieri*) is recorded from Australia. Affinities and distribution are considered for the genus and the species. A detailed description of the species is supplemented by a habit sketch of a flowering branch, analytical drawings of the flower and range of variation in shape of leaves.

Taxonomic history of the genus

The genus Duranta was described by Linnaeus (1753) with two species, *D. erecta* and *D. repens*, the types of which came from South America. It was placed in the group "Didynamia Angiospermia" where it was retained by Jacquin (1760, 1763), Murray (1774), Reichard (1778), Schreber (1791), Gmelin (1792), Persoon (1797, 1807), Willdenow (1800), Sims (1815), Ker (1817), Link (1822), Sprengel (1825), Dietrich (1842), and a few others. Adanson (1763) placed the genus in Section "II" of "Verbenae", Gleditsch (1764) in "Petalostemonum", Rüling (1774) in "Ringentes Antirrhina", Scopoli (1777) in "Personatae", Gaertner (1788) in "Plumieri", Jussieu (1789) in "Vitices", Necker (1790) in "Plasyrgophytum", Giseke (1792) and Batsch in "Personatar", Ventenant (1799) in "Pyrenaceae, and Reichenbach (1828) under the tribe "Verbeneae" in the Labiatae. In 1805, Jaume Saint-Hilaire proposed the family Verbenaceae for *Duranta* and other related genera. The family Verbenaceae was accepted for the genus by de Jussieu (1806), Kunth (1818), Bentham (1839, 1870, 1876), Endlicher (1838), Lindley (1847), Schauer (1847), Briquet (1895), Bailey (1906, 1913), H.J. Lam (1919) and by the majority of other botanists.

In 1829, Dumortier divided the Verbenaceae into two tribes: Verbeneae and Viticeae, with *Duranta* in the tribe Verbeneae. This tribe was accepted for the genus by Bartling (1830), Spach (1840), Schauer (1847), Grisebach (1862), Harvey (1868), Bentham (1876), Th. Durand (1888), Post & Kuntze (1904), Bailey (1906, 1913), Fletcher (1938), Lemée (1943) and others. Endlicher (1838) divided the family Verbenaceae into three tribes: Lippieae, Lantaneae and Aegiphileae, with *Duranta* in the tribe Lantaneae. This tribe was accepted for the genus by Meisner (1840), Endlicher (1841), Dietrich (1842), Brongniart (1843), Walpers (1845) and Sanders (1984). Bentham (1839) divided the Verbenaceae into four tribes: Verbeneae, Duranteae, Viticeae and Avicennieae, with *Duranta* in the tribe Duranteae. Subsequently, Bentham (1876) transferred the genus *Duranta* to the tribe Verbeneae. Schauer (1847) subdivided the tribe Verbeneae into seven subtribes: Spielmannieae, Monochileae, Casselieae, Verbeneae, Lantaneae, Duranteae and Petreeae, with *Duranta* in the subtribe Duranteae. The subtribe Duranteae was accepted for the genus by Bocquillon (1863).

Briquet (1895) reclassified the Verbenaceae and upgraded the tribe Verbeneae to a subfamily Verbenoideae. The latter consisted of six tribes: Euverbeneae, Lantaneae, Monochileae, Petraeeae and Citharexyleae, with *Duranta* in the tribe Citharexyleae. This classification was adopted by Dalla Torre & Harms (1904), Lam (1919), Junell (1934),

* The present treatment of the genus *Duranta* is the fourteenth in the series of taxonomic revisions in the family Verbenaceae in Australia. (See Munir, 1982, 1984a, 1984b, 1985, 1987a, 1987b, 1989, 1990a, 1990b, 1991, 1992, 1993a, 1993b.)

Moldenke (1959, 1971, 1980, 1983), Melchior (1964), Lopez-Palacios (1977), Raj (1983) and several others. The majority of botanists, however, have retained the genus in the Verbenaceae without reference to any subfamily or a tribe. In the present treatment, Briquet's (1895) classification of the Verbenaceae is followed in retaining *Duranta* in the tribe Citharexyleae.

Australian history of the genus

The first Australian records of naturalised *Duranta* were collected by Amalie Dietrich during 1863–1865, from near the Brisbane River, Queensland. Then more specimens were collected from the same area by K. Domin during 1910, C.E. Hubbard during 1930, S.T. Blake during 1931 and C.T. White during 1942. Recently, more collections have come from Stradbroke Island, Cape Hillsborough, Cairns and several other localities in Queensland.

In Northern Territory, naturalised *Duranta* was collected by C.E.F. Allen during 1919 and in South Australia it was recorded by R.Bates during November 1988.

The first written record of this genus in Australia was published by Bailey (1888) when he recorded the only known naturalised species of this genus *D. plumieri* (now synonym of *D. erecta*). Later, Bailey (1906) noted it as one of the "suspected poisonous plants of Queensland", and in 1913 he included it in his "Comprehensive Catalogue of Queensland Plants". Subsequently, Domin (1928) recorded the above species in his "Beiträge zur Flora und Pflanzengeographie Australiens" and Webb (1948) mentioned it in his "Guide to the Medicinal and Poisonous Plants of Queensland". Recent records of *Duranta* from Australia were enumerated by Moldenke (1959, 1971, 1980, 1983), Lord & Willis (1982), Stanley (1986), Hnatiuk (1990), Chapman (1991) and Smith (1991). It appears from the above publications, that the process of naturalisation of *Duranta* in Australia has been probably slow and mainly recent.

Chromosome numbers

Chromosome counts for *Duranta* are available from at least nine sources. All are based on counts of *D. erecta* (= *D. repens* and *D. plumieri*). These counts are based on material from outside Australia. The highest count (2n = 36) was reported by Darlington & Wylie (1955), Caro (1956), and Fedorov (1974), and the lowest count (2n = 16) by Hsu (1967). Diploid numbers of 24 and 32 were also recorded by Fedorov (1974). Others, Sharma & Mukhopadhyay (1963), Koul et al. (1976b), Bir & Sidhu (1976), Coleman (1982) and Gill et al. (1983) reported the diploid number to be 34. Counts for no other species have been seen.

DURANTA L.

Duranta L., Sp.Pl. edn 1, 2 (1753) 637; Gen. Pl. (1754) 284, No. 704; Jacq., Enum. Pl. Carib. (1760) 26; Jacq., Select. Stirp. Amer. Hist. (1763) 186; L., Gen. Pl. edn 4 (1764) 324, No. 786; Mill., Gard. Dict. edn 8 (1768) sphalm. "Durantia"; Giseke, Prael. Ord. Nat. Pl. (1792) 486; Willd., Sp. Pl. 3 (1800) 380, No.1197; J. St.-Hil., Expos. Fam. Natur. 1 (1805) 249; Juss., Ann. Mus. Hist. Nat. Paris 7 (1806) 75; Kunth in Humb., Bonpl. & Kunth, Nov. Gen. & Sp. Pl. 2 (1818) 253; Rchb., Consp. Veg. 1 (1828) 117, No. 2909; Dumort., Fam. Pl. (1829) 22; Bartl., Ord. Pl. (1830) 180); Endl., Gen. Pl. 1 (1838) 637, No. 3709; Spreng., Gen. Pl. 2 (1831) 480, No. 2371; Meisn., Pl. Vasc. Gen. 1 "Tab. Diag." (1840) 290; 2 "Commentarius" (1840) 199; Endl., Ench. Bot. (1841) 312; D. Dietr., Synop. Pl. 3 (1842) 372; Walp., Rep. Bot. Syst. 4 (1845) 78; Schauer in A. DC., Prod. 11 (1847) 615; Benth. in Benth. & Hook.f., Gen. Pl. 2 (1876) 1150; Briq. in Engl. & Prantl, Pflanzenfam. 4, 3a (1895) 159; F.M. Bailey, Weeds & Suspect. Poison. Pl. Qld (1906) 142; Compr. Cat. Qld (1913) 382; H.J. Lam, Verbenac. Malay. Archip. (1919) 27; Britton & P. Wilson, Sci. Surv. Porto Rico & Virgin Isl. 6 (1925) 146; Moldenke, Lilloa 4 (1939) 313; Publ. Carnegie Inst. Wash. No. 522 (1940) 196; Lemée,

Dict. Desc. Syn. Pl. Phan. 8b (1943) 652, sphalm. "Durantea"; Caro, Revista Argent. Agron. 23 (1956) 3; J.F. Macbr., Field. Mus. Nat. Hist. Bot. Ser. 13, Part 4 (1960) 681; Britton, Fl. Bermuda, Facs. of edn 1918 (1965) 316; D.N. Gibson in Standl. & L.O. Williams, Fl. Guatemala, Fieldiana Bot. 24, Part 9 (1970) 199; Moldenke, Fifth Summary Verbenac. etc. 1 & 2 (1971) 424, 474, 477, 487, 490, 491, 527, 756, 876; Ann. Missouri Bot. Gard. 60 (1973) 87; Lopez-Pal., Fl. Venezuela, Verbenaceae (1977) 291; Moldenke, Phytologia Mem. II, Sixth Summary Verbenac. etc. (1980) 379, 397, 398, 411; Moldenke in Dassan. & Fosberg, Fl. Ceylon 4 (1983) 277; Raj, Rev. Palaeobot. Palynol. 39 (1983) 367; R.W. Sanders, Sida 10, No. 4 (1984) 308, 309; T.D. Stanley in T.D. Stanley & E.M. Ross, Fl. S. E. Qld 2 (1986) 368; Jans.-Jac., Fl. Guianas (1988) 39; R.W. Sanders in R.A. Howard, Fl. Lesser Antilles, Part 3 (1989) 224; A.C. Smith, Fl. Vitien. 5 (1991) 175; Verdc. in Polhill, Fl. Trop. E. Afr. Verbenaceae (1992) 48; Jarvis et al., Regnum Veg. 127 (1993) 44; Greuter et al., Regnum Veg. 129 (1993) 379.

Lectotype: *D. repens* L., Sp. Pl. 2 (1753) 637. Designated by N.L.Britton, Fl. Bermuda (1918) 316, *fide* Jarvis et al., Regnum Veg. 127 (1993) 44 and Jarvis pers. comm. 10 Nov. 1993 & 6 Jan. 1994.

Castorea Plum. ex Mill., Gard. Dict. edn 4, Vol. 1 (1754) – according to Moldenke (1940, 1983) - *nom. illeg.*

Ellisia P. Browne, Hist. Pl. Jamaic. (1756) 262 – according to Moldenke (1940, 1983).
Type: *E. frutescens* P.Brown, loc. cit. (1756) 262, t. 29, fig. 1.

Shrubs or small trees. *Stem* branched, woody, subquadrangular, glabrous, pubescent, sometimes armed with spines, the branches often elongated and pendent. *Leaves* simple, decussate-opposite or whorled, entire or dentate-serrate, deciduous, chartaceous to subcoriaceous. *Inflorescence* axillary and terminal racemes. *Flowers* pedicellate, bracteate, bisexual, zygomorphic. *Calyx* persistent, gamosepalous, tubular, 5-ribbed, each rib terminating in a tooth, in fruit accrescent, fleshy and indehiscent or coriaceous and somewhat splitting away at maturity. *Corolla* gamopetalous, hypocrateriform, 5-lobed, zygomorphic; tube cylindric, straight or somewhat curved above, exserted from the calyx; lobes regular or oblique, spreading, usually unequal. *Stamens* 4, didynamous, included, inserted above the middle of the corolla-tube; filaments very short; anthers sagittate, dorsifixed, the cells parallel. *Ovary* more or less completely 8-locular, composed of 4 bilocular carpels, each locule with 1 ovule; style terminal, the stigma obliquely subcapitate. *Fruiting-calyx* flask-shaped, usually longer than and often enclosing the fruit. *Fruit* a drupe, the exocarp fleshy, the endocarp hard; pyrenes 4, each bilocular and 2-seeded. *Seeds* without endosperm.

Number of species: World ± 17 species and several infraspecific taxa; Australia: one naturalised species introduced from tropical America.

Derivation of name

The genus is named after Castor Durante, c.1529–1590, a French physician and botanist who was the Pope`s physician, and who wrote on West Indian plants.

Distribution (Map 1)

According to Moldenke (1973, 1983) and others, the genus *Duranta* is "widespread in subtropical and tropical America from Florida and Bermuda through the West Indies, Mexico, and Central America, to Argentina". Several species are widely cultivated for their white to purple flowers and bright orange fruits. Some frequently escape and become more or less naturalised. In Australia, it is represented by only one naturalised species *D. erecta*.

Comments

There has been some controversy about the type of the genus *Duranta*. As mentioned under the "History of the Genus", Linnaeus (1753) described this genus with two species *D. repens* and *D. erecta* but did not choose one as a type. A lectotypification of the genus, therefore, was needed. This seems to have been accomplished by Hitchcock & Green (1947) who specifically designated *D. erecta* as the lectotype for *Duranta*. Jarvis et al.

(1993) seem not to have accepted this typification because they believed that Britton (1918) was the first to choose *D. repens* as a type for the genus. Jarvis informed the present author (pers. comm. 10 Nov. 1993) that "the earliest choice seems to have been that of *D. repens* by Britton, *Flora of Bermuda* (1918), and in our recent list of Linnaean generic Names (*Regnum Vegetabile* 127. 1993), we have followed this choice". Britton (1918) recognised only one species *D. repens*, with *D. erecta* and *D. plumieri* in synonymy. Apparently it seems to be an ambiguous lectotypification because Britton gave no clear indication that he was choosing *D. repens* as the lectotype.

The present author wrote back to Jarvis and explained that there are also earlier but similar publications by Hiern (1877, 1900) in which *D. erecta* was accepted and *D. repens* and *D. plumieri* were in synonymy. If Britton`s publication constitutes valid lectotypification then Hiern`s earlier ones must be adopted for similar reasons. If, however, it is considered that neither constitutes valid lectotypification then one must follow Hitchcock & Green (1947) who specifically named *D. erecta* as the lectotype. In response to this second query, a facsimile message on behalf of Jarvis from N. Turland (6 Jan. 1994) reiterated Jarvis`s earlier opinion that "*Britton`s Flora of Bermuda* remains the earliest such designation". He further explained that "Britton may appear somewhat ambiguous in some of his designations, and his treatment of *Duranta* in *Flora of Bermuda* (1918) is an example of this. His genus description ends with the statement 'about 8 species, natives of tropical America, the following typical.' There then immediately follow *D. repens* L. Here Britton's use of the phrase 'the following typical' should, I believe, be interpreted as a designation of generitype, although admittedly it appears ambiguous when taken out of the context of the Flora as a whole. Britton explicitly states 'Type species: [name]' when he designates as generitype one of two or more species included in the Flora, or a species not in the Flora but, where the generitype is the only species included in the Flora, as is the case with *Duranta*, he consistently used the phrase 'the following typical'. In Britton & Brown's *An Illustrated Flora of the Northern United State, Canada and the British Possessions* ed. 2 (1913), further generitypes are designated in the same manner. Merely accepting one name and including another in synonymy does not constitute designation of a generitype. Therefore, *Duranta erecta* L. is not so designated in the publication by Hiern". In view of the above explanations by Jarvis and Turland, the present author has accepted *D. repens* as the lectotype of *Duranta*.

Moldenke (1971, 1973, 1983) acknowledged respectively 48, 50, and 53 species and infraspecific taxa in *Duranta*. Sanders (1984) disagrees with Moldenke and several other botanists and believe that *Duranta* has "only 17 species, none of which has well marked geographically coherent subdivisions". Nevertheless, he agreed with Moldenke on the polymorphic nature of its taxa and states that a "considerable variation exists in *Duranta*. However, many of the variants, which include named species, appear to be morphologically intermediate to other more widespread taxa, as well as appear to occupy zones of geographic sympathy of these taxa. This suggests that the variants are hybrids or taxa of hybrid origin. Although there is not yet any direct evidence of hybrids, I have demonstrated natural hybridisation in the related woody genus *Lantana*".

During palynological studies in the Verbenaceae, Raj (1983) examined five *Duranta* species and described their pollen grains as "elliptic in equatorial view (2:3)".

Affinities

Duranta is closely related to *Citharexylum* L. in its inflorescence being axillary and in having terminal racemes; flowers pedicellate and fruit drupaceous. Nevertheless, *Duranta* may easily be distinguished by its ovary being 8-locular; fruiting calyx longer than and often enclosing the fruit and beaked; fruit composed of 4 pyrenes, each 2-locular and 2-seeded. There are a few characters in common with *Rhaphithamnus* Miers. In both genera,

the inflorescence is racemose; flowers pedicellate; fruiting calyx tightly adnate to the fruit and enclosing it; stamens didynamous; fruit globose and fleshy. However, *Rhaphithamnus* can readily be identified by its 2 stamens being slightly exserted; anthers with divergent thecae; fruit blue, composed of 2 pyrenes, each 2-celled and 2-seeded.

Duranta erecta L., Sp. Pl. edn 1, 2 (1753) 637; Hiern in Warm. (ed.), Symbolae Fl. Brasil. Cent. Cogn. part 23 (1877) 711; Hiern, Cat. Afr. Pl. Welw. 4 (1900) 831; Urb., Symb. Antill. 4 (1911) 536 & ibid. 8 (1921) 599; Knuth, Feddes Repert. Sp. Nov. Beih. 43 (1927) 606; Caro, Revista Argent. Agron. 23 (1956) 6, fig. 1; Backer & Bakh.f., Fl. Java 2 (1965) 599; Bromley, Kew Bull. 39,No. 4 (1984) 803; Jans.-Jac., Fl. Guianas (1988)39, fig. 8; R.W. Sanders in R.A. Howard, Fl. Lesser Antilles, part 3 (1989) 225, fig. 92; Hnatiuk, Cens. Aust. Vasc. Pl. 2 (1990) 626; H. Keng, Conc. Fl. Sing.(1990) 193; A.C. Smith, Fl. Viti. Nov. 5 (1991) 176; Verdc. in Polhill (ed.), Fl. Trop. E. Afr. Verbenaceae (1992) 48, fig. 7.

Lectotype: Plumier's plate with analytical drawings of the flower and fruit, filed under the name *Castorea* (Library, University of Groningen, Netherlands. The precise location in the library is: Manuscript 98a, Department of Old and Rare Books. One syntype (plate) also in the same place. Photographs in AD!).

D. repens L., Sp. Pl. edn 1, 2 (1753) 637; Kuntze, Rev. Gen. Pl. 2 (1891) 507; Britton, Fl. Bermuda (1918) 317, fig. 339; Merr., Enum. Philip. Pl. 3 (1923) 381; Standl., Contr. U. S. Nat. Herb. 23, part 4 (1924) 1241; Britton & P. Wilson, Sci. Surv. Porto Rico Virgin Isl. 6 (1925) 146; Moldenke, Lilloa 4 (1939) 314; Publ. Carnegie Inst. Wash. No. 522 (1940) 196; L.J. Webb, Bull. Council Sci. Indust. Res. No. 232 (1948) 168; Sastri, Wealth India 23 (1952) 117; Moldenke, Fl. Madag.(1956) 40, fig.V-1-4; Résumé Verbenac. etc. (1959) 188, 190, 195, 196, 203, 204, 206, 208, 218, 250, 282–285, 426, 455; J.F. Macbr., Fl. Peru, Field Mus. Nat. Hist. Bot. Ser., Vol. 13, part 4 (1960) 685; Santapau, Rec. Bot. Surv. Ind, 16, edn 2 (1960) 191; Gooding et al., Fl Barbados (1965) 358, fig. 23; D.N. Gibson in Standl. & L.O. Williams (eds), Fl. Guatemala, Fieldiana: Bot. 24, part 9 (1970) 199, fig. 38; Moldenke, Fifth Summary Verbenac. etc. 1 & 2 (1971) 336, 343, 344, 346, 350, 362, 424, 474, 477, 487–491, 776, 782, 877; C.D. Adams, Fl. Pl. Jamaica (1972) 632; Moldenke, Ann. Missouri Bot. Gard. 60 (1973) 90; Jafri & Ghafoor, Fl. W. Pak. No. 77 Verbenaceae (1974) 18; Lopez-Pal., Revista Fac. Farm. Uni. Los Andes Mérida, No. 15 (1974) 26; Lopez-Pal., Fl. Venezuela, Verbenaceae (1977) 299, fig. 70; Moldenke, Phytologia Mem. II, Sixth Summary Verbenac. etc. (1980) 314, 326, 329, 331, 333, 336, 340, 341, 353, 379–400, 546–547; Lord & J.H. Willis, Shrubs & Trees Aust. Gard. edn 5 (1982) 225; Moldenke in Dassan. & Fosberg (eds), Fl. Ceylon 4 (1983) 278; Bromley, Kew Bull. 39, No. 4 (1984) 803; R.W. Sanders, Sida 10, No. 4 (1984) 311; T.D. Stanley in T.D. Stanley & E.M. Ross, Fl. S. E. Qld 2 (1986) 369, fig. 51J; O.W. Borrell, Fl. Kairiru Isl. New Guinea (1989) 145.

Neotype: *Patrick Browne s.n.*, Jamaica, undated, Herb. Linn. No. 806.2 (LINN). Designated by R.W. Sanders, Regnum Veg. 127 (1993) 44.

The following synonymy was taken from recent literature and was not researched in detail:

Castorea racemosa Plum. ex Mill., Gard. Dict. edn 4, 1 (1754) – according to Schauer (1847) – *nom. illeg.* Based on Plumier, Nov. Pl. Amer. Gen. (1703) 30, t.17.

Ellisia frutescens P. Browne, Civ. Nat. Hist. Pl. Jamaica (1756) 262, t.29, fig. 1 –according to Moldenke (1959, 1971, 1983).
Type: *P. Browne s.n.* Jamaica, (LINN, n.v., probably Herb. Linn. No. 806.1, microfiche!). According to Stafleu & Cowan (1976), "Browne sold his Jamaican herbarium to Linnaeus in 1758 through Collinson. It is now at LINN. - 103 original drawings of Jamaican plants by Ehret are [also] at BM ....."

Ellisia acuta L., Amoen. Acad. 5 (1760) 400 –according to Moldenke (1939, 1959, 1971).
Type: *Pugill s.n* , Jamaica (n.v.).

Duranta ellisia Jacq., Enum. Syst. Pl. (1760) 26; Select. Stirp. Amer. Hist. (1763) 187, t.176, fig.77 – according to Moldenke (1983) & R.W. Sanders (1984), *nom. illeg.* Based on *Ellisia frutescens* P. Browne (1756) 262, t.29, fig. 1. Type according to Stafleu & Cowan (1979) H–Le, "Jacquin's material from the West Indies in the Banks herbarium (now BM) is rare and consists of scraps or small specimens"

D. plumieri Jacq., Enum. Syst. Pl. (1760) 26; Select. Stirp. Amer. Hist. (1763) 186, t.176, fig.76; F.M. Bailey, Econ. Pl. Qld (1888) 31; Weeds & Susp. Poison. Pl. Qld (1906) 142; F.M.Bailey, Compr. Cat. Qld Pl. (1913)

382. – according to Lopez-Pal. (1977), Moldenke (1983) & R.W.Sanders (1984, 1989) – *nom. illeg.* Based in part on a Plumier's plate 17 (1703) and Linnaeus's *D. repens* and *D. erecta* (1753).

D. racemosa Mill., Gard. Dict. edn 8 (1768), sphalm. "*Durantia racemosa*". – according to Moldenke (1983) & R.W. Sanders (1984).
Type: *Houston s.n.*, Jamaica (n.v., 'photo NY!' – according to R.W. Sanders, 1984).

D. latifolia Salisb., Prod. Stirp. Hort. Allerton (1796) 108, *nom. nud.* – according to Moldenke (1983) & R.W. Sanders (1984).

D. dentata Rich. ex Pers., Synop. Pl. 2 (1806) 142 – according to Moldenke (1983) & R.W. Sanders (1984).
Type: "Hab. in Africa ? (herb. Richard)" (L or P, n.v.).

D. macrocarpa Kunth in Humb., Bonpl. & Kunth, Nov. Gen. & Sp. Pl. 2 (1818) 255; Schauer in A. DC., Prod. Syst. Nat. Veg. 11 (1847) 616 – according to Standley (1924).
Type: *Humboldt & Bonpland s.n.*, "crescit in Nova Hispania?" (P-Bonpl., microfiche!).

D. xalapensis Kunth in Humb., Bonpl. & Kunth, Nov. Gen. & Sp. Pl. 2 (1818) 255 – according to Moldenke (1983) & R.W. Sanders (1984).
Type: *Humboldt & Bonpland s.n.*, loc. incert. Mexico, undated (P-Bonpl., microfiche!).

D. microphylla Desf., Cat. Hort. Paris edn 3 (1829) 392, *nom. nud.* – according to Lopez-Pal. (1977).

D. plumieri Jacq. var. *strigillosa* Schauer in Mart., Fl. Braz. 9 (1851) 271, p.p. – according to Moldenke (1983) & R.W. Sanders (1984), *nom. illegit.* Based on *D. plumieri* Jacq. and *D. ellisia* Jacq.

D. integrifolia Todaro, Nuovi Gen. Nuovi Sp. Palmero (1858) 27 – according to R.W. Sanders (1984).

D. turbinata Todaro, Nuovi Gen. Nuovi Sp. Palmero (1858) 28 – according to R.W. Sanders (1984).

D. bonardi Guillard ex Bocq., Adansonia 2 (1862) 112 – according to Moldenke (1983).

D. parviflora Turcz., Bull. Soc. Nat. Moscow 36 (1863) 210 – according to R.W. Sanders (1984).

D. plumieri Jacq. var. *alba* Mast. in Gard. Chron. III, 3 (1888) 44, fig. 9 – according to A.C. Smith (1991).

D. plumieri Jacq. var. *ellisia* (L.) Hort. ex Woodrow, Garden. Ind. (1889) 420 – according to Moldenke (1973, 1983).
Type: As for *Ellisia acuta* L.

D. plumieri Jacq. var. *glabra* Hiern ex Niederl., Bol. Mens. Mus. Prod. Argent. 3 (31) (1890) 322 – according to Moldenke (1973, 1983).

D. repens L. var. *alba* (Mast.) L.H. Bailey in L.H. & E.Z. Bailey, Hortus (1930) 225 –according to A.C. Smith (1991).
Type: As for *D. plumieri* var. *alba* Mast.

D. rostrata Hort. ex Wehmer, Pflanzenst. edn 2, 2 (1931) 1023 – according to Moldenke (1973, 1983).

D. repens L. var. *canescens* Moldenke, Phytologia 1 (1940) 436 – according to R.W. Sanders (1984).
Type: *Killip & Smith (No. 14990)*, at an altitude of 1000–1500 m on the northern slope of the mesa de los Santos, Santander Sur, Colombia, 11–15.xii.1926 (F, n.v.).

D. peruviana Moldenke var. *longipedicellata* Moldenke, Bull. Torrey Bot. Club 68 (1941) 502 – according to R.W. Sanders (1984).
Type: *F.L. Herrera 3209*, valley of the Urubamba, Machupicchu, alt. 2200m, Cuzco, Peru, -.x.1931 (F, holotype, n.v.; photo of holotype in NY – seen by R.W. Sanders, 1984).

D. repens L. var. *microphylla* (Desf.) Moldenke, Phytologia 1 (1941) 483.
Type: As for *D. microphylla* Desf.

D. erecta L. var. *alba* (Mast.) Caro, Revista Argent. Agron. 23 (1956) 11 – according to A.C. Smith (1991).
Type: As for *D. plumieri* Jacq. var. *alba* Mast. (1888).

D. repens L. var. *serrata* Moldenke, Phytologia 7 (1959) 81 – according to R.W. Sanders (1984).
Type: *Venturi 9059*, loc. incert. (NY, holotype, n.v. – seen by R.W. Sanders,1984).

D. macrophylla Bose, Handbook Shrubs (1965) 46, 107, 122, 123 – according to Moldenke (1973, 1983).

D. repens L. var. *lopez-palacii* Moldenke, Phytologia 26 (1973) 177 – according to R.W. Sanders (1984).
Type: *Ruiz-Teran & M. Lopez-Figueiras 1923*, in the vicinity of San Antonio, about 5 km below El Portachuela (El Ramal) in the Cordillera de Los Andes, at an altitude of 1820 m, in the district of Sucre, Mérida, Venezuela, 28.v.1971 (NY, holotype, n.v. –seen by R.W. Sanders, 1984).

Typification of D. erecta & D. repens.

Linnaeus (1753) based *Duranta* and its two [syntype] species on Plumier's description (with accompanying illustration) (1703) namely "Castorea repens, spinosa" and "Castorea racemosa, flore caeruleo, fructu croceo". These species were renamed by Linnaeus (1753) *D. repens* and *D. erecta*. Plumier's illustration was subsequently published by J. Burman (1756) with a drawing of a twig not in Plumier's publication as t. 79 and cited by Linnaeus (1759). Nevertheless, Linnaeus did not designate any type for *D. repens* or *D. erecta*. The selection of types for these taxa is therefore necessary. A discrepancy in the typification of these taxa occurs in the literature. For instance Caro (1956) selected Burman's (1756) plate 79 as the lectotype of *D. erecta*. This was accepted by Bromley (1984), Jansen-Jacobs (1988), Sanders (1989) and Verdcourt (1992). However, the publication of this plate by J. Burman (1756) postdates the Linnaean protologue (1753), and can therefore not be taken as the lectotype. To typify the name it is necessary to determine the element used by Linnaeus in preparing the protologue of *D. erecta*. According to Gillis & Stearn (1974), Plumier's original illustrations (total c. 6000), now preserved in Bibliotheque Centrale, Museum National d'Histoire Naturelle, Paris, were not available to Linnaeus when preparing the 'Species Plantarum' (1753). A set of 508 copies of these drawings was made by Claude Aubriet in Paris in 1733 for Herman Boerhaave in Leiden, and came to be known as the "Codex Boerhaavianus" (Stafleu & Cowan 1983, Polhill & Stearn 1976). This set was seen and used by Linnaeus during his stay in Holland in 1738. According to Polhill & Stearn (1976), "About 50 species seemed to be based solely or principally on Plumier's drawings not available to him when preparing the 1753 *Species Plantarum*". After Boerhaave's death in 1739, these drawings were acquired by J. Burman, who began to publish copies of them in 1756 as *Plantarum Americanarum Fasciculus*. The descriptions published with the copies of the drawings were by J. Burman. The set of drawings is now preserved in the Department of Old and Rare Books in the Library of the Rijksuniversiteit Grongingen, Netherlands. Plate 79 of Burman's work, named by him *Duranta inermis* L., agrees in every detail with the copy of the original drawing used by Linnaeus in preparing the protologue of *D. erecta* (1753).

There are two drawings in the Library of Groningen University, each with almost identical habit sketch of a branch with flowers and fruits. Both were possibly seen by Linnaeus while preparing the protologue. One of them, however, has been supplemented with analytical drawings of the flower and fruit. Since the original drawings used by Linnaeus are extant, the type should be chosen from that material. The more detailed plate (with analytical drawing) is chosen here as the lectotype of *D. erecta*.

The type of *D. repens* remained undecided for a considerable period. Moldenke (1983) and Sanders (1984) suggested Linn. Herb. 806·1 as a "Possible Type" of *D. repens* and this was accepted by A.C. Smith (1991). In the same publication Sanders (1984) proposed Linn. Herb. 806.2 as a "Possible Type" of *D. erecta* and in 1989 he [Sanders] recorded the same number [806.2] as a "Type" of *D. repens*. A few years later, Verdcourt (1992) cited Plumier's t.17 as a type of *D. repens*. The confusion about the type of *D. repens* persisted because there are no original elements for *D. repens*, apart from Plumier's t.17 which is a generic illustration covering both *D. erecta* and *D. repens* and can therefore not be used to interpret only one of them. Since the material on which Plumier's t.17 was based does not seem to be extant, I follow R.W. Sanders (1993) who designated Linn. Herb. 806.2 (LINN) as a neotype of *D. repens*.

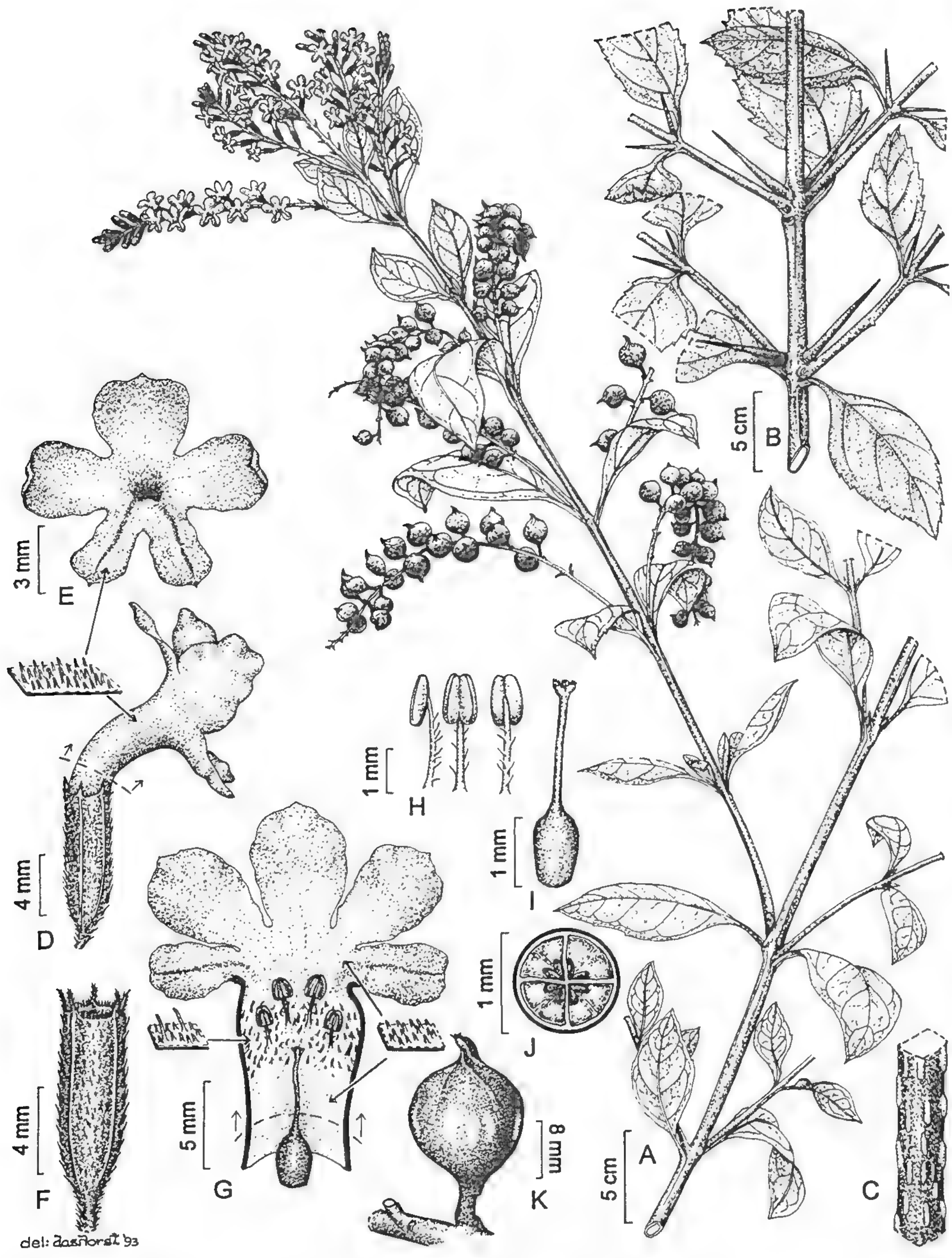


Fig. 1. *Duranta erecta* L. (A - K, *G.R.M. Dashorst & A.A. Munir 6250* : AD). A, habit sketch of a branch with flowers and fruit; B, stem with axillary spines; C, portion of stem showing 4-angles and speckles on bark; D, flower (arrows indicate papillose areas in D, G); E, top view of corolla-tube and corolla-lobes; F, 5-angled calyx-tube with minute teeth at the rim; G, longitudinally cut open corolla showing androecium and gynoecium; H, stamens with hairy filaments; I, gynoecium; J, transverse section of ovary; K, fruit.

Description (Fig. 1 & 2)

Shrub up to 7 m tall. *Branches* subquadrangular, drooping or trailing, unarmed or spiny, sparsely appressed-pubescent, becoming glabrous with age. *Leaves* short-petiolate; lamina ovate, elliptic or obovate, membranous-chartaceous, (15-) 20–75 (-90) mm long, (12-) 15–50 (-60) mm wide, obtuse, acute or shortly acuminate at apex, entire or coarsely serrate above the middle, cuneate-attenuate at base into the short petiole, sparsely appressed-pubescent on both sides, soon becoming subglabrous, primary and secondary veins slightly prominent, secondary veins 4–6 pairs; petiole (1-) 3–10 (-15) mm long, appressed-pubescent. *Inflorescence* terminal and axillary, 10–30 cm long; racemes many-flowered, erect or usually recurved or pendent, 3–10 (-15) cm long, appressed-pubescent; peduncle 5–15 mm long. *Flowers* fragrant; bracts minute, linear, 1–4 mm long or the lower ones occasionally subfoliaceous and exceeding the calyx; pedicel 1–5 mm long; usually appressed-pubescent. *Calyx* tubular, accrescent, 3–7 mm long, glabrescent, appressed-pubescent or canescent outside, glabrous inside; tube 5-angled, with 5 minute teeth at the rim; teeth triangular at base, subulate at apex, 0.5–1 mm long. *Corolla* mauve, light bluish-purple or white, hypocrateriform, puberulous outside, pubescent inside, often glandular specially in the throat, the puberulence often canescent in bud; tube 6–10 mm long, 1.5–2 mm diam., surpassing the calyx by 2–3 mm; lobes oblong, elliptic-oblong or almost orbicular, obtuse, usually puberulent within and outside, 3–5 mm long, 2.5–3.5 mm wide. *Stamens* inserted above the middle of the corolla-tube; filaments 0.5–1.5 mm long, with a few hairs; anthers oblong, ± 1 mm long. *Ovary* subglobose, ± 1 mm diam., glabrous; style included, filiform, glabrous, 2–3 mm long; stigma minutely capitate, 4-lobed. *Fruit* orange-yellow, subglobose or obpyriform, glabrous, (5-) 7–10 (-14) mm diam., completely enclosed by the accrescent orange-yellow shiny calyx which is prolonged into 1–2 mm long curved beak.

Specimens examined (collections seen: Australian 25, non-Australian 15)

AUSTRALIA: QUEENSLAND: *Blake 2325*, Petrie, ca 29 km N of Brisbane, .iii.1931 (BRI); *Croat 52691*, Gold Creek, 1.6 km W of Brookfield, ca 16 km W of Brisbane, 28.viii.1981 (QRS); *Dietrich 739*, Brisbane River, 1863–1865 (AD); *Dillewaard & Stanley 607*, Brisbane, on river bank, 20.v.1981 (BRI, CANB); *Dillewaard & Stanley 729*, Stradbroke Island, Dunwich, 27.vii.1981 (BRI); *Hawkeswood A56*, Millaa Millaa, Atherton Tableland, 5.x.1980 (BRI); *Hubbard 2744*, Mt Gravatt, near Brisbane, 24.v.1930 (BRI, K); *Forster 6611*, Black Gin Creek, Timber Reserve 580, Wide Bay District, 1.iv.1990 (BRI, MEL); *Francis s.n.*, Myers Ferry, Southport, -.iv.1920 (BRI); *Lyons 47*, Queerah, corner of Robert Road and Bruce Highway, Cairns, 17.vii.1987 (BRI); *Rogers s.n.*, near Bowen, 2.vii.1957 (BRI); *Scarth-Johnson 1175A*, Cooktown, near bottom of Grassy Hill, -.xi.1980 (BRI); *Shield s.n.*, Gin Gin, 11.vii.1963 (BRI); *Stanley 558*, base of Mt Archer, near Rockhampton, 18.ii.1980 (BRI); *Stanley 1011*, between Bundaberg and Bargara, 17.iii.1980 (BRI); *Staples 140572/6, 6A, 6B*, 3.2 km W of Kuranda, Kennedy Highway, 14.v.1972 (BRI 3 spec., CANB); *Thompson 37*, Landing Creek near Cape Hillsborough, -.v.1985 (BRI); *Volck 04740*, Cooktown, -.iii.1971 (BRI); *White s.n.* Enoggera Creek, 1920 (BRI); *White 11861*, Wellington Point, Moreton Bay, 15.xi.1942 (BRI 2 spec.); *White s.n.*, Hercules Bank, Brisbane River, undated (BRI 268211).

NEW SOUTH WALES: *Hicks s.n.*, Tenterfield, -.iii.1913 (NSW 231655); *Lawrence s.n. & McBarron 21458*, Woodville, 1.iv.1976 (NSW 231598); *McBarren L7*, corner Cordeaux and Oxley streets, Campbelltown, 21.xi.1969 (NSW); *Salasoo 2571*, 3.2 km W of Kyogle, 1.i.1963 (NSW 231658).

SOUTH AUSTRALIA: *Bates 13968*, near old ruins of One Tree Hill, Para Wirra Road, 29.xi.1988 (AD).

NORTHERN TERRITORY: *Allen T21*, Darwin, -.xi.1919 (NSW 231663).

PAPUA NEW GUINEA: *Hoogland 6573*, Markham Valley, ca 9.6 km inland from Lae, 5.xi.1959 (CANB).

PHILIPPINES: *Frake 351*, Pasanan, Zamboang del Norte, Mindanao, 21.xi.1957 (CANB).

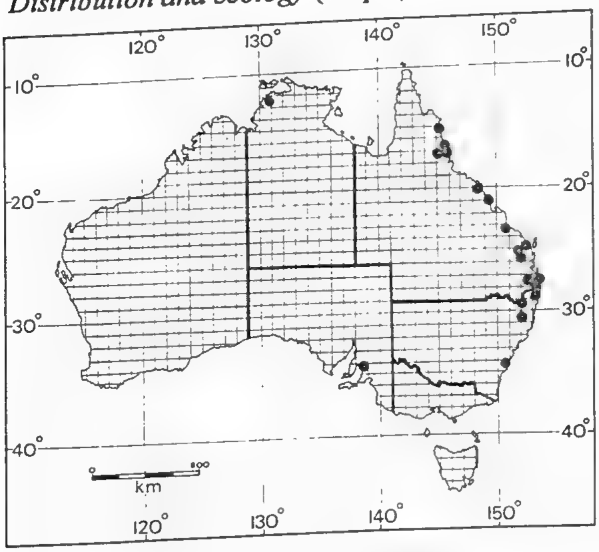
EAST INDIES: Herb. *Schomburgk s.n.*, loc. incert. undated (AD 97942899).

INDIA: *Bhattacharya 03*, Sonarpur, -.v.1981 (AD, CAL).

CHINA: *Chow & Wan 187*, Xishuanbanna, Yunnan, -.1980 (AD, IBSC n.v.); *Shi 14706*, Dinghushan, Guangdong, 29.v.1984 (AD, IBSC n.v.); *Yip 227*, Guangzhou, Guangdong, 17.iv.1981 (AD, IBSC n.v.).

ARGENTINA: *Leguizamon 5754*, Gandelaria, San Juan, Misiones Prov., -.xi.1949 (AD, BAB, n.v.); *Montes 722*, Lib. Gral. San Martin, Puerto Rico, Misiones Prov., 5.v.1948 (AD, BAB, n.v.).

Distribution and ecology (Map 1)



Map. 1. Distribution of *D. erecta* in Australia

In Australia, *D. erecta* is known to occur chiefly in Queensland and New South Wales with only a single record each from Northern Territory and South Australia. Distribution in Queensland is scattered along the east coast, particularly in the area between Cooktown and the New South Wales border. Majority of localities within this area are in the pastoral Districts Cook, North Kennedy [on Atherton Tableland], Wide Bay and Moreton. In New South Wales, the main distribution is in the north-eastern part of the State between Kempsey and the Queensland border. Outside this area, one distinct and most southerly locality in the State is near Campbelltown. Records of this taxon from Northern Territory and South Australia are known respectively from Darwin and north-east of Adelaide near Para Wirra Recreation Park.

According to Moldenke (1983), this taxon occurs "almost throughout subtropical and tropical America from the southernmost United States to Argentina; introduced and often naturalised in many parts of tropical Africa, Asia, Australia, and Oceania".

According to Australian collectors' field notes, it grows on river banks in gravelly sandy soil, foreshore slopes in open forest, on sandy, alluvial or granite soils. also recorded along roadsides and with scrubby vegetation in grazing paddock. Moldenke (1983) recorded it as a common plant of woods, thickets, hedgerows, fencerows, and roadsides. Gibson (1970) recorded this species from thickets, secondary forest, hedges, along roadsides and at an altitude of 500–2600 meters.

Comments

In Australia and elsewhere, this species has been recorded under the name *D. plumieri*, *D. repens* or *D. erecta*. The confusion on the correct name of this species started when Burman (1756) apparently in error picked up Linnaeus's adjectival name "inermis" for *D. erecta* and published Plumier's plate 79 under that name. Subsequently, Jacquin (1760, 1763) repeated the same error by picking up Linnaeus's adjectival names "inermis" for *D. erecta* and "spinosa" for *D. repens*, and placed these into synonymy of his own species *D. plumieri*. In the second edition of "Species Plantarum", Linnaeus (1763) published *D. plumieri* Jacq. and cited his own adjectival names "D. spinosa" and "D.inermis" in synonymy. Since then, the confusion on the proper name of this taxon has been perpetuated, with most early botanists using *D. plumieri* Jacq. and later botanists using *D. repens* L. or *D. erecta* L. Recently, Caro (1956) and Bromley (1984) discussed the problem at length and concluded that *D.erecta* was the proper name for this taxon. Many botanists, however, are still using the name *D. repens* which is now a synonym of *D. erecta*. According to Bromley (1984), "Hiern (1877) should be followed as he was the first botanist

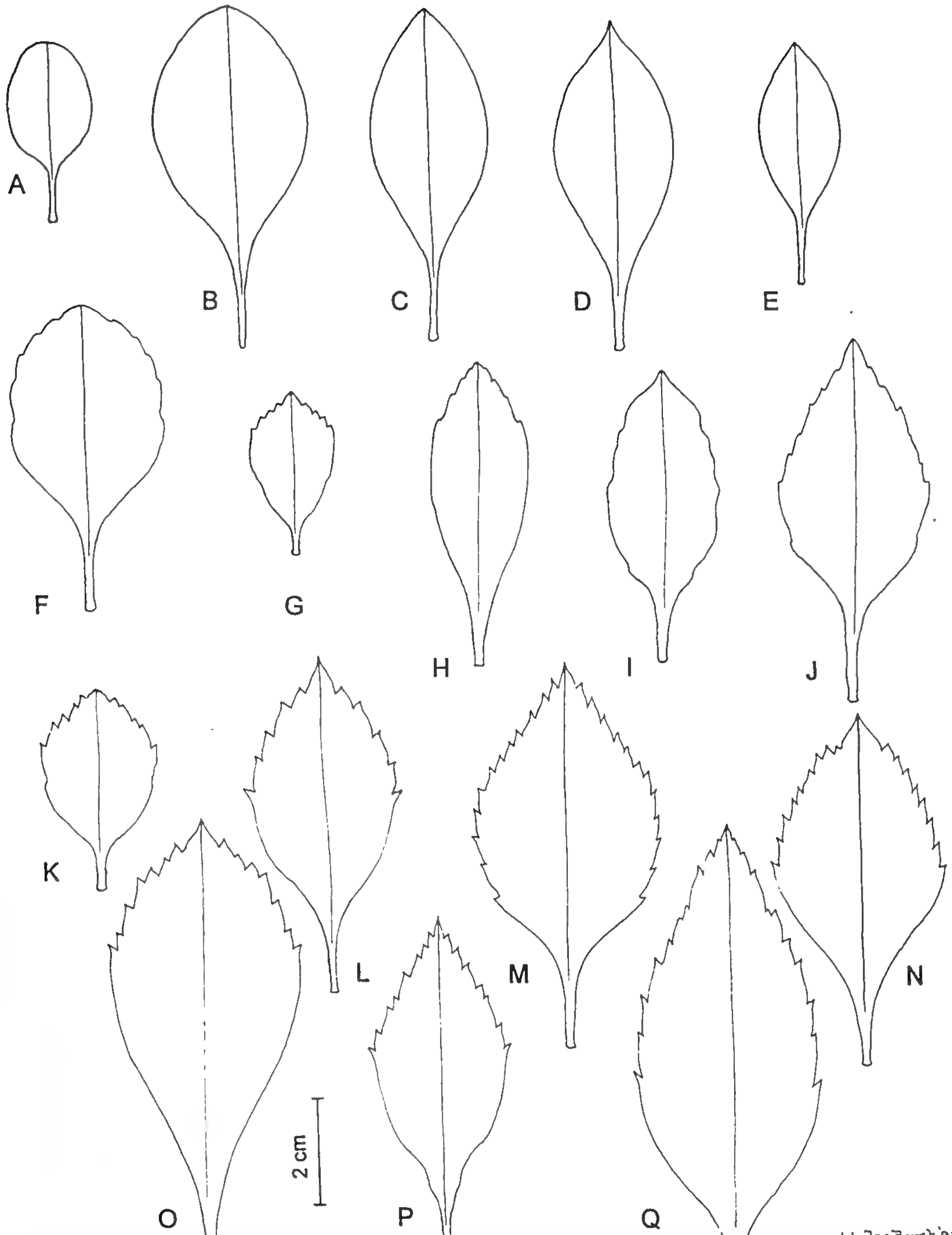


Fig. 2. Range of variation in shape of leaves of *Duranta erecta* L. A, *C.T. White 11861*: BRI; B, *I.B. Staples 140572/6*: BRI; C, *I.B. Staples 140572/6B*: BRI; D, *L. Rogers s.n.*: BRI 005734; E, *C.T. White 1186*: BRI; F, *P. Thompson 37*: BRI; G, *P.I. Foster 6611*: BRI; H, *A. Dietrich 739*: AD; I, *C.E. Hubbard 2744*: BRI; J, *I.B. Staples 140572/6*: CANB; K, *I.B. Staples 140572/6A*: BRI; L, *T. Stanley 1011*: BRI; M, *H. Salasoo 2571*: NSW; N, *H. Dillewaard & T. Stanley 607*: BRI; O, *E. Volck 0474*: BRI; P, *H. Dillewaard & T. Stanley 607*: CANB; Q, *C. Lyons 47*: BRI.

who cited *D. erecta* with *D. repens* in synonymy". On the contrary, Sanders (1984), who apparently did not see Hiern's (1877) publication, states that "Kuntze (1891) was the first author to combine *D. repens* and *D. erecta* and, in so doing, gave priority to *D. repens*". At that stage, Sanders (1984) was probably unaware of Caro (1956) who used the name *D. erecta* and selected Burman's (1756) t. 79 as the lectotype of this species. (See typification of *D. erecta*).

This species is frequently planted for ornamental purposes in tropical and subtropical regions of both hemispheres. It has often been established as an escape. In Australia, it is widely cultivated as a hedge or ornamental plant, and according to Bailey (1913) "This common and excellent hedge-plant has run out into the pasture very little, but should the fruit at any time become the food of some animal the plant will become a great pest, as it bears fruit abundantly". Bailey's apprehension was justified because it has become naturalised in several parts of Australia. Recently, Stanley (1986) recorded it "naturalised in the Moreton and Wide Bay districts" in Queensland. During present research, it has been found naturalised in a few other pastoral districts in Queensland as well as in parts of neighbouring States.

Bailey (1906, 1913) recorded under *D. plumieri* three varieties namely var. *alba*, var. *ellisia,* and var. *normalis* i.e. the normal or the typical variety. All these varieties are distinguished from each other chiefly by the colour of their flowers. Under var. *ellisia*, Bailey (1913) also recorded forma *variegata* in which the leaves are marked with irregular patches of different colours. All these infraspecific taxa are possibly grown in Australian gardens and nurseries, but only the typical variety is definitely known to be naturalised in Australia. The present author has been unable to distinguish these varieties in the specimens examined because the corolla-colour often completely fades in dry state. Recently published regional floras have not recorded any naturalised variety under this species.

Webb (1948) stated that this species was "cultivated and spontaneous. Fruits said to have caused illness and death of children in Queensland, with symptom of sleepiness, high temperature, rapid pulse and convulsions. The plant has also been suspected of poisoning live stock, and is said to contain a saponin". Chopra, Badhwar & Nayar (1941) claim that "Juice of fruits [is] toxic to mosquitoes in dilutions up to 1:100. Leaves contain saponin, and fruits said to contain alkaloid analogous to narcotine". Merck (1940) asserted that "bark of *D. ellisia* [now syn. of *D. erecta*] yields glucoside duratin". According to Standley (1924), "The fruit has been used as a febrifuge, and stimulant properties have been ascribed to the flowers".

In view of the presence and absence of prickles, generally on different parts of the same plant, it has been commonly named "prickly duranta" or "smooth duranta". There are several other common names attributed to this species of which a few popular ones are "golden-dewdrop", "pigeon-berry", "heliotrope-bush", "skyflower", "angel's whisper" and "poison macca".

Britton (1918) recorded unusually long pedicels ranging "½–2½" long" [i.e. 12.2–63 mm]. Such a long pedicel has not been observed during present investigation.

According to Moldenke (1939, 1940, 1971, 1973, 1983), this species is "an extremely variable and polymorphic shrub or a small tree". In Sanders's view (1984), it "is very variable, especially with respect to habit, to the overall shape, margins and apex of the leaf, and to the presence and size of thorns". During present investigation, a significant range of variation in shape of leaves has been observed in Australian material of *D. erecta* (see Fig. 2).

Affinities

D. erecta is nearest to *D. mutisii* L.f. in its mature leaf-blades being glabrous or subglabrate beneath and inflorescence branches bracteate or with 1 or 2 much reduced leaves below the flowering portion. Nevertheless, *D. erecta* may easily be distinguished by its leaf-venation being not impressed adaxially. There are several characters in common between *D. erecta*, *D. peruviana* Moldenke and *D. stenostachya* Torado. According to Sanders (1984), however, "*D. peruviana* and *D. stenostachya* may be conspecific with *D. repens* [=*D. erecta*], each forming a geographic race".

Var. *alba* differs from the typical variety by its white corolla and var. *microphylla* by its mature leaf-blades being mostly or uniformly less than 15 mm in length.

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Index to Scientific Names

Names: New names and combinations are in **bold**. Synonyms, misapplied, misspelt, illegitimate or invalid names are in *italics*.

Page numbers: Page numbers in **bold** refer to main taxonomic treatment. Page numbers asterisked refer to figures and maps.

J. Adelaide Bot. Gard. 16: 17–22 (1995)

SPYRIDIUM ERYMNOCLADUM, A NEW SPECIES FROM EYRE PENINSULA, SOUTH AUSTRALIA, AND NEW STIPULE CHARACTERS IN AUSTRALIAN RHAMNACEAE

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Abstract

This new species is described and illustrated for the first time. It is characterised by the pair of stipules at each node being joined between the leaf they subtend and the branchlet for most of their length and consistently greatly overlapping the leaf base and stipular pair of the node above. It is currently known from two localities approximately 15 km apart in two different environmental associations. New characters involving two types of fusion of the stipules of each pair are used to clarify the affinities of this species and are of potential use in defining generic relationships of the Australian stellate-haired Rhamneae.

This new species of *Spyridium* is distinctive in the imbricate scarious brown stipular pairs which completely envelop the branchlets. It is described to make it available in a study of generic delimitation within the Australian Rhamnaceae by Dr Kevin Thiele of the Australian National Herbarium, Canberra, and to encourage investigation of its conservation requirements.

Spyridium erymnocladum W.R. Barker, *sp. nov.*

Species nova stipulis imbricatissimis ramos plane occulentibus in genere unica.

Holotypus: *D. Paull s.n.*, viii.1993, a few kilometres N of Karkarook, an abandoned, now demolished, railway siding halfway between Kielpa and Rudall. In low abundance. Mixed mallee spp. (*Eucalyptus incrassata*, *Euc. leptophylla*) with 5 m canopy with up to 7 m emergents; shrub layer with *Melaleuca uncinata* dominant; diverse ground layer [species list for site attached to specimen]; white sandy soil. AD99336201. *Isotypi*: CANB, PERTH.

Low woody *shrub* c. 30 cm high (*Hall 239*); *indumentum* eglandular, persistent, on branchlets, stipules, leaves, bracts and pedicels variously comprising antrorse, straight to wavy hairs c. 0.5–1 mm long and/or shorter stellate hairs with radiating arms c. 0.1–0.2 mm long; *branchlets* persistently densely tomentose with antrorse hairs c. 0.5–1 mm long covering shorter stellate hairs with arms c. 0.1–0.2 mm long, the indumentum exposed only after leaf drop and the decay of the stipules, finally losing indumentum and exposing an intricate transverse ribbing from the former attachment of the stipules and leaf. *Stipules* at successive nodes greatly imbricate, completely enclosing the branchlets, long-persistent, each pair fused along the margin between the leaf and branchlet over much of their length (c. 90%), the resulting pair broadly ovate, 3.5–4 mm long, with an abaxial channel marked by the stipular midribs and clasping the young leaf and two acuminate teeth separated by an apical cleft, dark brown, shiny, scarious, glabrous apart from the long antrorse hairs 0.4–1 mm long lining the margins and the short-armed stellate pubescence on the midribs. *Leaves* narrowly angled to branch, slightly spreading distally, the *petiole* largely hidden by the stipules below, slender, 0.8–1.5 mm long, pale, stellate-pubescent, with longer antrorse hairs at apex on abaxial side; *blade* linear through the revolute margins, 3.5–6.5 mm long, 0.8–1 mm wide, flexile, appearing uncinate from the apical cluster of antrorse hairs, without a mucro, the adaxial surface grey-green, not grooved, densely shortly stellate-pubescent, the abaxial surface occasionally exposed along midline, pale, long antrorse-

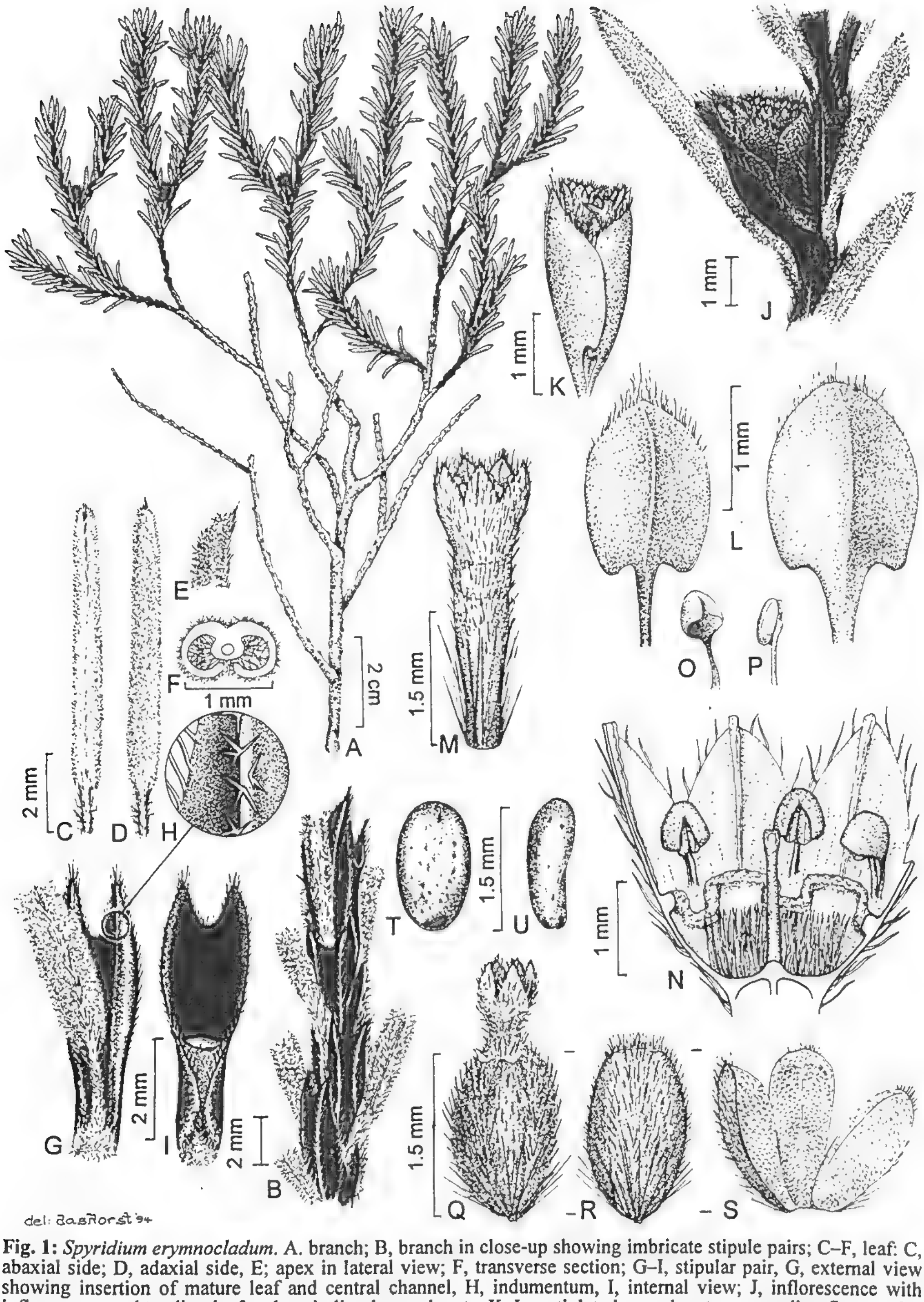

Fig. 1: *Spyridium erymnocladum*. A. branch; B, branch in close-up showing imbricate stipule pairs; C–F, leaf: C, abaxial side; D, adaxial side, E; apex in lateral view; F, transverse section; G–I, stipular pair, G, external view showing insertion of mature leaf and central channel, H, indumentum, I, internal view; J, inflorescence with inflorescence-subtending leaf and encircling brown bracts; K, L, petiolate brown bracts surrounding flowers; M, flower; N, upper half of flower in longitudinal section; O, petal; P, stamen; Q–S, fruit: Q, with persistent floral tube, R, prior to dehiscence, S, following dehiscence; T, U, seed. (*D. Paull AD99336201*).

pubescent. *Inflorescence* apparently axillary (but see Notes below), subtended by a normal leaf and stipular pair, surrounded by imbricate scarious brown bracts extending to the tip of the flowers; *bracts* shortly petiolate, concave, broadly ovate, acute, glabrous but for antrorse hairs along the margins. *Flowers* c. 7, externally covered by antrorse hairs, 1.5–2 mm long on pedicel, to 1 mm long on ovary, and to 0.5 mm long on floral tube and sepals; *pedicel* 0.3 mm long; *ovary* 1 mm long, narrow obovoid topped within floral tube by dense erect hairs 0.3 mm long; *floral tube* 0.8 mm long; *sepals* 0.7 mm long; *disc* 0.5 mm long, prominent; *petals* 0.5 mm long, spathulate, enclosing the anthers; *style* included, 0.9 mm long, shortly 3-lobed at apex. *Fruits* 1 or 2 per infructescence, ellipsoid, 2 mm long, antrorse-pubescent, topped by persistent floral tube, at length dehiscent from apex; *cocci*: not all 3 developing, the wall white, membranous, minutely white-papillose on the two inner sides, the outer side at least initially fused to ovary wall, lacking a basal hole; *seed* compressed ellipsoid, 1.5 mm long, 0.9 mm wide, shiny, dark brown, flecked with black; *caruncle* easily detached and left at base of coccus on removal of seed. Fig. 1.

Distribution

S. erymnocladum is known from two collections made in 1986 and 1993 from north-eastern Eyre Peninsula from sites approximately 10-15 km apart between the towns of Cleve and Darke Peak.

Ecology

Under Laut's (1977) classification of South Australian environments these collections come from the Hambidge (*Paull s.n.*) and Mt Desperate (*Hall 239*) environmental associations of the Wirrula environmental province. The collectors' notes confirm the different ecologies of the two localities. Unlike the *Paull* collection (see under Holotypus), *Hall 239* was found in low frequency confined to a hill top in sandy loam and ironstone amongst the regenerating shrubs *Calytrix tetragona, Hakea cycloptera, Acacia farinosa* and *Eremophila gibbifolia*. The height of this vegetation and presumably the *Spyridium* itself was unusually low as both were in a state of regeneration soon after a fire (Mrs T. Hall, pers. comm. Feb. 1994).

Conservation status

The frequency of occurrence of the species requires clarification. As it apparently occupies two habitat types and tracts of native vegetation have survived in the region it is likely to be more widespread. On the present information it seems advisable to rate it as vulnerable, with a 2V rating under the systems of Lang & Kraehenbuehl (1987) and Briggs & Leigh (1988).

Notes

The species epithet derives from the Greek *erymnos*, fenced, and *klados*, branch, alluding to the conspicuous overlapping stipules which completely shield the branchlets, a feature unknown amongst other members of the genus.

This is not *Cryptandra uncinata*, long a puzzling species described from South Australia. The latter has been shown by Davies (1987; confirmed by Dr R.J. Chinnock, pers. comm., Jan. 1994) to be *Eremophila sturtii* (Myoporaceae).

Dr K. Thiele's observation (pers. comm. Dec. 1994) that inflorescences of other species of *Spyridium* are terminal, with subsequent production of a shoot from an axil below it giving the impression of an axillary inflorescence, is confirmed in this species. In the two specimens seen, the inflorescences, all at fruiting stage, are single on each leaf-bearing branchlet, with a new shoot of similar length produced past each.

Specimens examined

SOUTH AUSTRALIA. EYRE PENINSULA: *T. Hall 239*, 16.x.1986. W of main Cleve – Kimba road in Campoona Hill area, c. 1 km NE or SE of High Bluff, on W side of N–S vehicular track. AD; *D. Paull s.n.*, see Holotypus.

Stipule characters in Australian Rhamneae and the relationships of *S. erymnocladum*

New characters in stipule morphology have been useful in assessing the relationships of *S. erymnocladum.* They are likely to prove useful in the re-evaluation of generic delimitation in the stellate-haired Rhamneae, a group confined to Australasia (Suessenguth 1953). Other unpublished work by Dr B.L. Rye (pers.comm. 1994; partly in Rye 1995) and Dr K. Thiele (pers. comm. 1994) involving characters in the inflorescence and fruit indicates that these genera must be redefined. In particular, this incomplete survey of stipule arrangement further calls into question current generic delimitation of the two allied genera *Spyridium* and *Cryptandra*, which, following Suessenguth (1953), is based solely on the greater length of the floral tube (hypanthium) in the latter. Previously Conn (1983) called the limits of these genera into question, while Barker & Lang (1987) alluded to the possibility that floral characters separating these genera may have evolved more than once as adaptations to different modes of pollination.

The closest affinities of *S. erymnocladum* apparently lie with species currently placed in both *Cryptandra* and *Spyridium* in which the two stipules subtending each leaf are fused along their adjacent margins in between the leaf and branch. The combined stipular pair forms a distinctive channel which clasps the younger leaves. Species with this feature include *Cryptandra waterhousii* (Fig. 2E), *C. leucophracta, Spyridium leucopogon, S. phylicoides, S. eriocephalum* (the generic type, Fig. 2D), *S. tridentatum* of South Australia, *S. subochreatum, S. halmaturinum* (in part) and *S. bifidum.* In none of these species do the stipules subtending adjacent leaves overlap to completely obscure the branch as in *S. erymnocladum.* Stipules are free in other species of *Spyridium*, including *S. spathulatum, S. nitidum, S. vexilliferum, S. coactilifolium, S. halmaturinum* (in part), *S. parvifolium, S. thymifolium* (Fig. 2C), *S. phlebophyllum* and *S. tricolor* (Barker & Rye 1993, fig. 1B). Other species of *Cryptandra*, such as *C. tomentosa, C. propinqua, C. ericifolia* (the generic type, Fig. 2F) and *C. amara*, exhibit a second type of stipular fusion. In this case stipules of each pair are not united between the leaf and branch, but are fused on the abaxial side of the branch below the point of attachment of the leaf.

Stipule morphology should assist in defining species groups and their relationships within the Australian stellate-haired Rhamneae. Free stipules are found not only in some species of *Spyridium* but also in *Pomaderris, Trymalium* and *Siegfriedia* (Fig. 2B) and widely disparate genera such as *Rhamnus* (Fig. 2A). Among these *Siegfriedia* and some species of *Pomaderris* share with *Rhamnus* the presumably plesiomorphic (primitive) state of the stipules being quite separate on either side of the leaf. In other species of *Pomaderris*, those of *Spyridium* listed above with free stipules, and *Trymalium* the stipules overlap between the leaf and the branchlet. *Cryptandra leucophracta* and *C. waterhousii*, through possession of stipules fused between the leaf and the branch, appear more closely related to the species of *Spyridium* with this trait than to the other listed species of *Cryptandra.* The former species also shares the apparent synapomorphies of most species of *Spyridium* of the persistent brown bracts which surround the inflorescence and a leaf-like inflorescence-subtending bract, which from the very dense white stellate pubescence is white on the upper side in contrast to the upper side of the leaves which through their sparser indumentum are grey-green in colour. Stipular fusion below the point of leaf attachment is a separate synapomorphy of the group of species of *Cryptandra* which includes the generic type. Whether these states of stipular placement and degree of fusion evolved only once will be gauged on how they correlate with other character transformations in cladistic analyses.

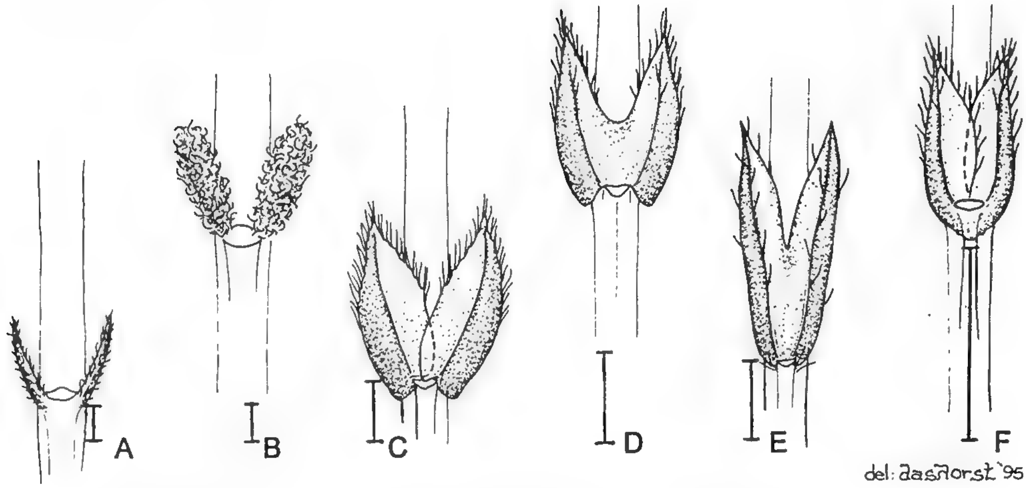

Fig. 2: Stipules in Rhamnaceae (with leaf removed and indumentum on branchlets not shown), indicating the two ways in which fusion between stipules subtending the same leaf has developed in Australian genera. A, *Rhamnus alaternus* (*D.E. Symon AD98663570*); B, *Siegfriedia darwinioides* (*A.S. George 9305*); C, *Spyridium thymifolium* (*D.J.E. Whibley 9014*); D, *Spyridium eriocephalum* var. *eriocephalum* (*W.L. Quinn 58*); E., *Cryptandra waterhousii* (*L.D. Williams 12821*); F, *Cryptandra ericifolia* (*Anon. AD98005086*). Scales = 1 mm.

With a generic revision pending, where should the new species be placed: in *Spyridium* with its closest relatives, which include the generic type, even though hypanthium length character at present used to delimit the two genera would indicate that it should be placed in *Cryptandra*, or alternatively in *Cryptandra*, the older name which would be taken up were the *Cryptandra-Spyridium* clade combined under one genus? The new generic system of Australian stellate haired Rhamneae is likely to involve recognition of further genera than currently recognised (Dr K. Thiele, pers.comm. Dec. 1994). Accordingly, I have chosen the former course of action, to name the species under the present two-generic system with what are considered its closest relatives.

Acknowledgements

Dr Kevin Thiele and Dr Barbara Rye are thanked for their constructive comments on the manuscript and for imparting aspects of their unpublished work in the Australian Rhamnaceae. Mr Gilbert Dashorst is thanked for his skilful illustrations.

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A NEW SOUTH AUSTRALIAN SPECIES OF *PULTENAEA* (FABACEAE, MIRBELIEAE)

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Abstract

Pultenaea insularis J.Z. Weber is described from Kangaroo Island, South Australia supplemented by an illustration of a flowering branch and analytical drawings.

Only recently a few specimens collected by Mrs B.M. Overton of this species came to my attention and it was immediately realised that it is distinct.

Pultenaea insularis J.Z. Weber, *sp. nov.*

P. insularis I. Holliday *et al.*, Kangaroo Island's Native Pl., p. 19, fig. (1994), *nom. nud.*

Caulis et ramis tenuis, prostratus, pubescens, ad nodos stoloniferus; folia dispersa, lamina lanceolata, 2.5–6 mm longa, scabrida; flores axillares, quoque singularis in pedunculis elongatis; calyx 5-fidus labiis subaequalis, bracteolis 2, tubo insidentibus; corolla papilionacea, 4–5 mm longa, flavescens; germen sessile, dispermum; stylus subulatus, ascendens; stigma simplex, minuta.

Type: *M. Jusaitis & J. Val* [Black Hill Native Flora Park No. 38], 3.xii.1992, Beyeria Conservation Park (35°48'S, 137°35'E), Kangaroo Island (holo.: AD 99237298; iso.: CANB, MEL, NSW).

Spreading to prostrate shrub with wiry branches to 60 cm high, rooting at nodes, with woody branches 0.5–2 mm thick, green to reddish-brown, pubescent with antrorse hairs when young, puberulous when older. *Leaves* petiolate, alternate to trimerous, crowded to 1–5 mm apart along the branches; *stipules* paired, clasping triangular, 1.5–2 mm long, glabrous, broadly membranous, medially costate, light to dark brown, often partly united by hyaline margins above the petiole; *petiole* short, cylindric, c. 0.5 × 0.3 mm, glabrous to stiff-ciliate, light-green; *lamina* elliptical, 2.5–6 × 1.5–3 mm, margin flat or recurved to revolute, with tip mucronate and recurved, green to dark-green, sometimes with a reddish tint, upper surface puberulous to scabrous with antrorse appressed white hairs, midrib distinct below. *Flowers* pedunculate, solitary, 4–5 mm long, mainly towards the apex of branches. *Peduncle* filiform, 10–16 × c. 0.2 mm, densely covered with stiff white hairs, erect when flowering, extending in length and curving downwards as the fruit matures. *Bracteoles* two, attached at the base of calyx and clasping, narrow-lanceolate to almost acicular, 1.5–2 mm long, costate, almost leathery, brown, with few appressed white hairs. *Calyx* narrow-campanulate, c. 0.3 mm long, green with red lines corresponding with the centre of each of 5 acuminate teeth, maturing brown, outside white-pubescent with antrorse appressed hairs; upper 2 lobes broader, triangular and united for half their length, lower 3 longer than the tube, narrow-triangular, tapering into filiform tips; calyx tube glabrous inside. *Corolla* in bud vivid red, later predominantly yellow; *standard* obcordate, c. 5 × 6 mm, notched centrally, strongly reclinate and spreading at nearly right angles to the keel, slightly folded in the centre, with involute margins, yellow except the reddish midline and centre, claw narrow, c. 1.5 mm long; *wings* obovate-spathulate, c. 5 × 2 mm, bright yellow, auriculate, suddenly contracted into c. 1 mm long claw; *keel* rather shorter than wings, asymmetrically obovate, obtuse, c. 4.5 mm long, auriculate above the distinct c. 1 mm long

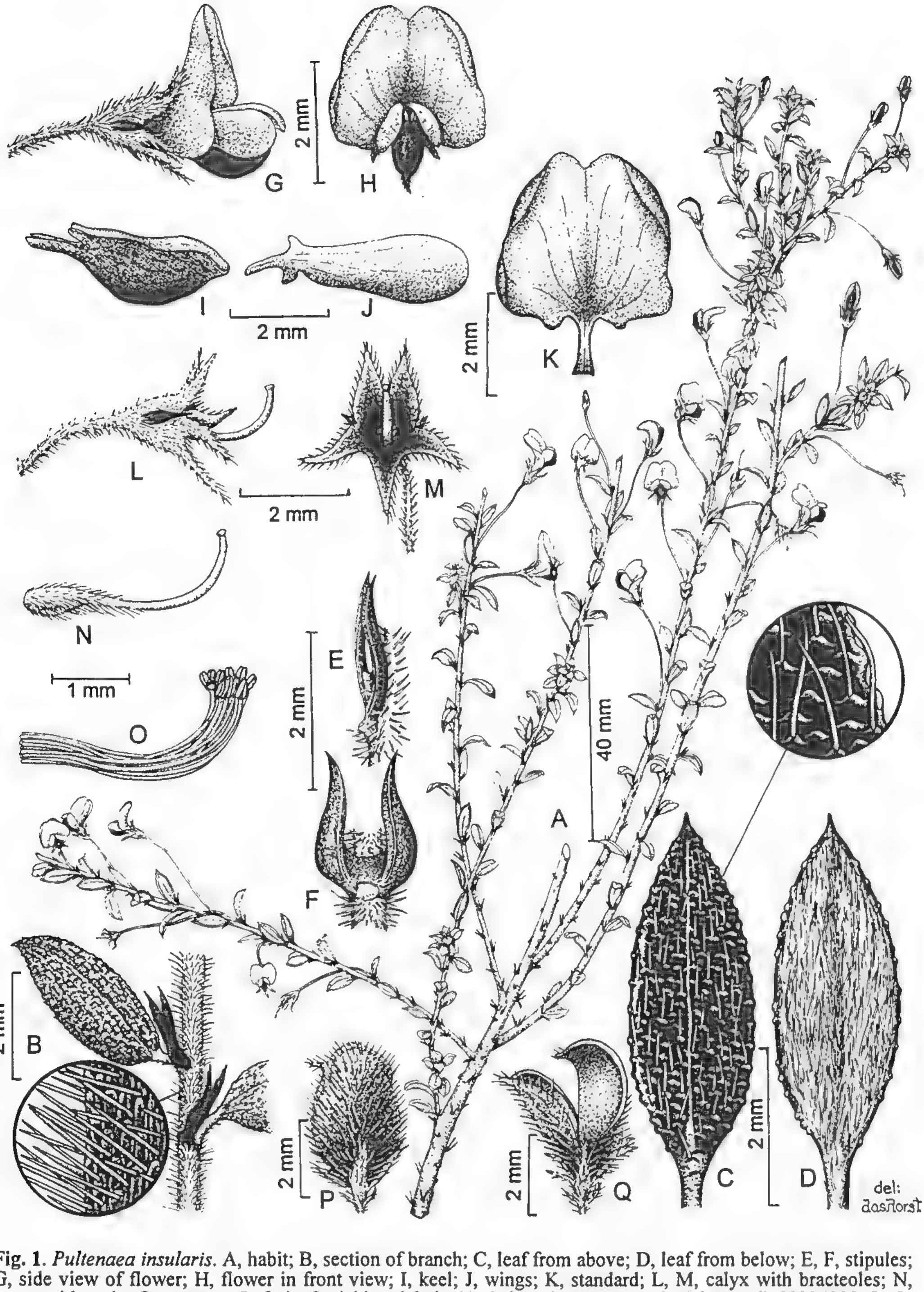

Fig. 1. *Pultenaea insularis*. A, habit; B, section of branch; C, leaf from above; D, leaf from below; E, F, stipules; G, side view of flower; H, flower in front view; I, keel; J, wings; K, standard; L, M, calyx with bracteoles; N, ovary with style; O, stamens; P, fruit; Q, dehisced fruit. (A–0, based on *Jusaitis & Val s.n.* AD 99237298; P, Q, *Overton 2239* (AD).)

claw. *Stamens* 10; *filaments* free, filiform, 4–5 mm long; *anthers* ovoid, c. 0.5 mm long, basifixed. *Ovary* laterally compressed-ovoid, c. 1 mm long, gradually tapering into the ascending c. 2 mm long style; *stigma* terminal, minute; *ovary* and base of style white antrorse-villous. *Pod* compressed-ovoid, c. 4 × 2 mm, pubescent, maturing brown to dark-brown, dehiscing longitudinally and halves twisting laterally, finally deciduous with the calyx and peduncle. *Seed* not seen.

Comments

Plants flower profusely from November to December. The flowers are held upright and are presumably insect pollinated. In fruiting stage the peduncle curves down and lowers the pod.

The name refers to its origin from Kangaroo Island.

Only one colony of c. 600 plants was observed in Beyeria Conservation Park of 184 ha where it was found in disturbed scrub. It was growing on sandy-clay soil in open forest of *Eucalyptus* sp. and *Melaleuca* sp. which has had several partial clearances by chaining or burning. Prostrate and semiprostrate clumps are often matted around tree trunks up to 50 cm high or scrambling in high grasses.

P. insularis is similar to *P. pedunculata* Hooker in regard to its wiry filiform but stiff branches, the roots produced along the branches, the stiff antrorse pubescence, the clasping broadly membranous stipules, the long filiform peduncles and the shape of the flower. It differs, however, because *P. pedunculata* commonly has larger flowers (to 8 mm long), longer narrow-lanceolate to narrow-elliptic leaves (5–12 × 2–3 mm) and nearly glabrous lamina ending in long-mucronate to an almost pungent straight tip.

P. pedunculata has not been found on Kangaroo Island, but occurs in similar habitats on Eyre Peninsula, in Southern Lofty and South-Eastern regions of South Australia as well as in New South Wales, Victoria and Tasmania.

Conservation status: Known only from a single locality in Beyeria Conservation Park where several hundred plants occur; suggested status 2VC.

Key to species

Flowers 4–5 mm long, solitary; leaves elliptical, 2.5–6 mm long, tip mucronate and recurved .... *P. insularis*
Flowers 4–8 mm long, sometimes twin; leaves narrow-lanceolate to narrow-elliptic, 5–12 mm long, tip acute, almost pungent, straight .... *P. pedunculata*

Specimens of *P. insularis* examined were found in the same locality:

SOUTH AUSTRALIA: Beyeria Conservation Park, *B.M. Overton 1624*, 10.xi.1991; *B.M. Overton 1625*, 22.xi.1991 & *B.M. Overton 2299*, 28.iii.1993.

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A NEW AUSTRALIAN SPECIES OF *DUBOISIA* R. BR. (SOLANACEAE)

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Abstract

A new species of *Duboisia, D. arenitensis* Craven, Lepschi & Haegi, is described from the Northern Territory, Australia. The species is illustrated, its distribution mapped, and an identification key provided. The hyoscine and hyoscyamine content of the single collection known is 0.137% and 0.04%, respectively.

Introduction

The solanaceous genus *Duboisia* R. Br., consisting of three species, occurs in Australia and New Caledonia with one species, *D. myoporoides* R. Br., common to both areas. The other two species, *D. hopwoodii* (F. Muell.)F. Muell. and *D. leichhardtii* (F. Muell.)F. Muell., are restricted to Australia. The genus was treated comprehensively by Haegi (1983) and has been treated (for differing numbers of species) in several floras (e.g. Heine, 1976; Purdie *et al.*, 1982; Stanley and Ross, 1986; Conn, 1993). Species of the genus contain alkaloids and *D. myoporoides* and *D. leichhardtii–myoporoides* hybrids are cultivated for alkaloid production, notably for hyoscine and hyoscyamine. Plantations have been established in southeastern Queensland for this purpose. A concise account of the commercial utilisation of *Duboisia* in Australia has been given by Matheson (1979).

During a botanical exploration trip to western Arnhem Land, Northern Territory, in March 1984, a *Duboisia* was collected by L.A. Craven and G.M. Wightman on the floristically rich sandstone plateau in this region. The plant could not be identified with any of the known species of the genus and further study of the herbarium material has demonstrated that it possesses a unique combination of character states. It has been concluded that this material represents a new species of the genus, described here as *D. arenitensis.*

Duboisia arenitensis Craven, Lepschi & Haegi, *sp. nov.*

Frutex 1.5 m altus. *Folia* glabra; petiolo vel obsoleto usque 20 mm longo; lamina angustissime elliptica usque anguste ovata interdum ovati-elliptica, saepe falcata, 70 × 15 mm usque 100 × 25 mm. *Inflorescentia* paniculata, foliosa proximale, bracteata distale; pedicello 1.5–3.5 mm longo. *Calyx* 2.25–4.5 mm longus; lobis angustissime triangularibus usque sublinearibus, 1.25–3 mm longis, longitudine 0.6–0.7 calycis. *Corolla* 5–8 mm longa; lobis anguste ovatis usque anguste triangularibus, 1.75–4 mm longis, longitudine 0.4–0.5 corollae. *Stamina* 4, duobus 1–1.5 mm longis et ceteribus 2–2.5 mm longis, staminodio carenti. *Fructus* non visus.

Typus: Australia, Northern Territory, vicinity of Mt Gilruth, lat. 13°10'S, long. 133°06'E, 27.iii.1984, *Craven & Wightman 8292* (holo.: CANB; iso.: A, AD, DNA, E, G, K, L, MEL, MO, P, US).

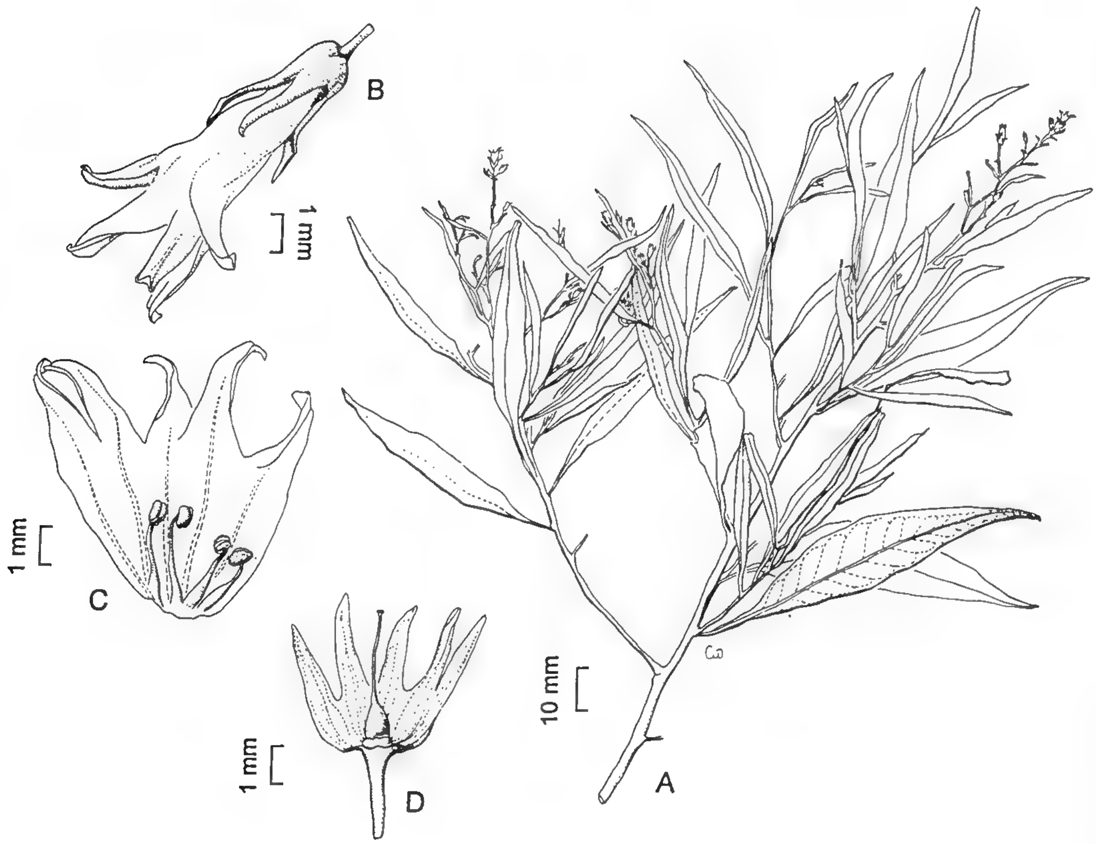


Fig. 1. *Duboisia arenitensis.* A, flowering branchlet; B, flower; C, Corolla of opened flower showing the four stamens; D, calyx of opened flower showing the gynoecium. From type collection.

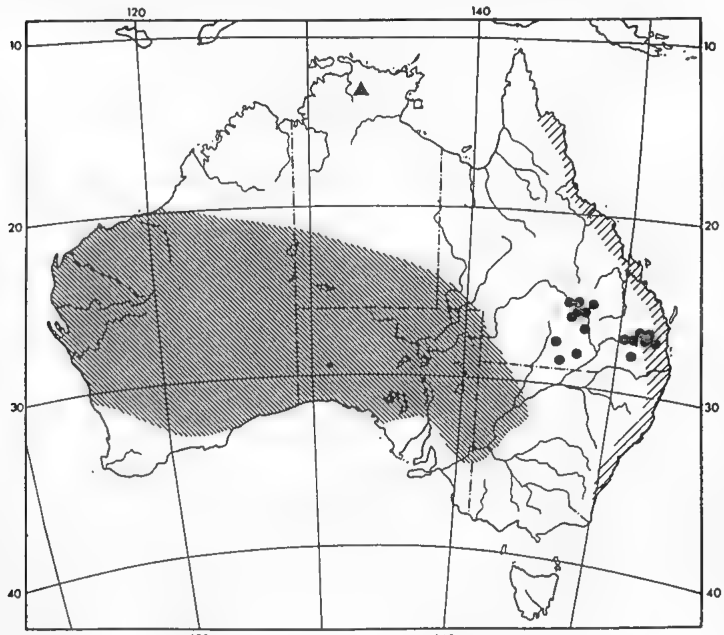
Shrub 1.5 m tall, branches glabrous excepting some minute deciduous hairs at the nodes. *Leaves* glabrous; petiole obsolete or up to 20 mm long; lamina narrowly to very narrowly elliptic to narrowly ovate or occasionally ovate-elliptic, often falcate, 70 × 15 mm to 100 × 25 mm, progressively becoming reduced on flowering branchlets and then sublinear and straight in shape and 30 × 2 mm, the base attenuate, the apex long acuminate, the margin flat and entire to slightly and irregularly sinuate, the midrib prominent abaxially and adaxially plane or adaxially impressed proximally and prominulous distally. *Inflorescence* paniculate, leafy proximally, bracteate distally, with minute glandular hairs on the axes and bracts; pedicel glabrous or with sparse minute glandular hairs, 1.5–3.5 mm long, straight to slightly curved. *Calyx* with minute glandular hairs, these sparse on the abaxial surface and

more numerous on the adaxial surface, 2.25–4.5 mm long; lobes very narrowly triangular to sublinear, 1.25–3 mm long, 0.6–0.7 times as long as the whole calyx, the apex acute to subobtuse. *Corolla* with minute simple and minute glandular hairs on the abaxial surface and glabrous on the adaxial surface excepting the dense minute papillae on the distal portion of the lobes, 5–8 mm long; lobes narrowly ovate to narrowly triangular, 1.75–4 mm long, 0.4–0.5 times as long as the whole corolla, the apex acuminate to narrowly acute. *Stamens* 4, 2 of these 1–1.5 mm long and the others 2–2.5 mm long, staminode absent. *Gynoecium* 2–3 mm long. *Fruit* not seen. Fig. 1.

Distribution and ecology

The species is known only from the type gathering which was collected near Mt Gilruth on the western Arnhem Land plateau. Map 1.

The solitary plant from which this collection was made grew in shrubby woodland on sandy alluvium along a seasonal creek on the sandstone plateau. Five or six additional plants were observed growing nearby in a similar habitat.



Map 1. Distributions of *Duboisia* species in Australia. *D. arenitensis* ▲; *D. hopwoodii*; *D. leichhardtii* ●; *D. myoporoides*.

Chemistry

Leaf material from the type collection has been analysed by Dr Bill Griffin, University of Queensland, Brisbane. The alkaloid content was low (hyo-scine 0.137%, hyo-scyamine 0.04%) (Griffin, pers. comm., 1990).

Although *D. arenitensis* may not warrant cultivating for its alkaloids alone, the species should be brought into cultivation for experimental purposes. A research program to obtain hybrids between the new species and those presently cultivated should be undertaken, and field research conducted to establish whether or not crop improvements could be made, either in alkaloid quality and/or quantity or in agronomic factors such as productivity, disease resistance, tolerance to harvesting, etc. Intergeneric and interspecific hybridisation is known to result in novel qualitative and/or quantitative chemical profiles in Solanaceae (Evans, 1986; El-Iman *et al.*, 1991) and the potential for *D. arenitensis* to contribute to crop improvement in *Duboisia* should be investigated.

Notes

In the features reported in this paper, there is no single character state which distinguishes *D. arenitensis* from its congeners; the species is separated on a combination of characters. The major differences between the species are given in Table 1.

Duboisia arenitensis not only extends the geographic range of the genus into the northern part of the Northern Territory (Map 1), but also extends its ecology. The species occurs within the monsoon zone of northern Australia where it is a component of the woodlands developed on the extensive sandstone plateau of Arnhem Land. *Duboisia myoporoides* occurs in the coastal region of eastern Australia, usually in humid eucalypt forests or rainforests and often in disturbed sites. *Duboisia leichhardtii* occurs in open eucalypt forest and eucalypt woodlands in southcentral and southeastern Queensland. The remaining species, *D. hopwoodii*, is widely spread within the arid zone and occurs in a range of communities including mallee and mulga woodlands.

The specific epithet is derived arbitrarily from the geological name for sandstone, arenite, and refers to the colloquial name used by botanists for sandstone plateau country of northern Australia, i.e. "the sandstone".

Table 1 – Major distinguishing characters of *Duboisia* species

	D. arenitensis	*D. hopwoodii*	*D. leichhardtii*	*D. myoporoides*
Leaves	Usually petiolate, rarely subsessile or sessile. Petiole 1–20 mm long.	Sessile to subsessile, rarely petiolate. Petiole 3–10 mm long.	Sessile to petiolate. Petiole 1–8 mm long.	Sessile to petiolate. Petiole 1–30 mm long.
Lamina	Narrowly elliptic to narrowly ovate, rarely sublinear (on flowering branchlets). Often falcate.	Narrowly to very narrowly elliptic to linear.	Narrowly to very narrowly ovate-elliptic, rarely narrowly ovate or narrowly elliptic.	Narrowly obovate to narrowly obovate-elliptic.
Lamina length	30–100 mm	24–125 mm	51–135 mm	38–150 mm
Lamina breadth	2–25 mm	1–13 mm	7–22 mm	1–43 mm
Lamina apex	Long acuminate	Narrowly acute to acuminate, rarely apiculate.	Acuminate or narrowly acute.	Blunt, acute to obtuse, rarely rounded.
Pedicel length (in flower)	1.5–3.5 mm	1.5–5 mm	10–16 mm	2–7 mm
Calyx length	2.25–4.5 mm	1.5–4.5 mm	1.5–3.2 mm	1.2–3.2 mm
Calyx lobe shape	Very narrowly triangular to sublinear	Triangular to broadly triangular, occasionally acuminate.	Very narrowly triangular to more or less linear.	Triangular to broadly triangular.
Calyx lobe length	1.25–3 mm	0.3–2 mm	0.5–1.5 mm	0.2–0.8 mm
Calyx lobe length: overall calyx length.	0.6–0.7	0.3–0.8	0.5–0.6	0.1–0.3
Corolla length	5–8 mm	7–15.5 mm	13–19 mm	4–7 mm
Corolla lobe shape	Narrowly ovate to narrowly triangular.	Broadly ovate to ovate-elliptic or orbicular.	Very narrowly triangular to linear.	Broadly ovate to ovate-elliptic or rarely orbicular.
Corolla lobe length:	1.75–4 mm	1–5 mm	6.5–11.5 mm	1.3–3.5 mm
Corolla lobe length, overall corolla length	0.4–0.5	0.1–0.3	0.5–0.6	0.3–0.5

Key to the species of *Duboisia*

1. Leaves with the lamina mostly narrowly elliptic to linear.
   2. Leaves petiolate, rarely subsessile or sessile. Calyx lobes very narrowly triangular to sublinear. Corolla lobes narrowly ovate to narrowly triangular, 0.4–0.5 times as long as the corolla; corolla 5–8 mm long .... *D. arenitensis*
   2. Leaves sessile or subsessile, rarely petiolate. Calyx lobes triangular to broadly triangular. Corolla lobes broadly ovate to orbicular, 0.1–0.3 times as long as the corolla; corolla 7–15.5 mm long .... *D. hopwoodii*
1. Leaves with the lamina mostly obovate to obovate-elliptic or ovate to narrowly ovate or ovate-elliptic.
   3. Leaves with the lamina mostly obovate to obovate-elliptic, apex acute to obtuse. Corolla lobes broadly rounded .... *D. myoporoides*
   3. Leaves with the lamina mostly ovate to narrowly ovate or ovate-elliptic, apex acuminate. Corolla lobes narrowly acute.
      4. Pedicel 1.5–3.5 mm long. Corolla 5–8 mm long, corolla lobes 1.75–4 mm long .... *D. arenitensis*
      4. Pedicel 10–16 mm long. Corolla 13–19 mm long, corolla lobes 6.5–11.5 mm long .... *D. leichhardtii*

Acknowledgements

Bill Griffin is thanked for carrying out the alkaloid analysis of *D. arenitensis*. Catherine Wardrop prepared the illustration.

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THE SPECIES OF *WURMBEA* (LILIACEAE) IN SOUTH AUSTRALIA

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Abstract

Nine species of *Wurmbea* Thunb. are recognised in South Australia. *W. biglandulosa* (R. Br.)Macfarlane, *W. deserticola* Macfarlane and *W. sinora* Macfarlane are recorded for the first time; *Wurmbea biglandulosa* ssp. *flindersica, W. centralis* ssp. *australis, W. decumbens, W. dioica* ssp. *citrina, W. dioica* ssp. *lacunaria, W. latifolia* ssp. *vanessae* and *W. stellata* are described. A key, together with notes on each species is provided.

Macfarlane (1980) revised the genus for Australia. He placed *Anguillaria* R. Br. under *Wurmbea* and recognised *W. dioica* (R. Br.)F. Muell., *W. centralis* Macfarlane, *W. latifolia* Macfarlane and *W. uniflora* (R. Br.)Macfarlane as occurring in South Australia. Before this only one species, *W. dioica* (as *Anguillaria dioica*) was listed for South Australia (J.M. Black 1922, 1943). Macfarlane stated that he had seen no live material of South Australian species. The present author has made extensive field studies of taxa discussed in this paper, has cultivated most and studied herbarium material. Several trips have been made to other states to allow further comparisons to be made. For information on the nomenclatural history, general morphology, biology and ecology of *Wurmbea* see Macfarlane 1980.

Key to the South Australian species of *Wurmbea*

1 Lower leaves paired (almost opposite), basal, of same shape and size 2
1: Lower leaves well separated, often of different shape and size 4

2 Leaves with serrate margins, flowers unisexual, nectaries 1 per tepal, a single band of colour .... 6. *W. latifolia*
2: Leaves without serrate margins, flowers hermaphroditic, nectaries 2 per tepal 3

3 Lower leaves narrow-linear, decumbent, flower 1, < 7 mm across, capsule elongate on a decumbent stem .... 3. *W. decumbens*
3: Lower leaves broadly linear-lanceolate, flowers several, > 7 mm across, capsule ovoid on an erect stem .... 2b. *W. centralis* ssp. *australis*

4 Nectary 1 per tepal, forming a single band of colour, flowers unisexual .... 5. *W. dioica*
4: Nectaries 2 per tepal, flowers hermaphroditic 5

5 Flower single, tepals < 3 mm broad 6
5: Flowers several, tepals > 3 mm broad 8

6 Flower < 10 mm across, tepals clasping filament (at least in living plant), outer margin of nectary winged ... 7
6: Flower > 10 mm across, tepals not clasping filament, outer margin of nectary not winged .... 8. *W. stellata*

7 Basal leaf linear-lanceolate, receptacle thickened, anthers yellow, spring flowered .... 9. *W. uniflora*
7: Basal leaf filiform, receptacle not thickened, anthers purple, winter flowered .... 7. *W. sinora*

8 Tepals connate, forming a cup-shaped tube up to 1/3 of length, nectaries small, elliptical with margins elevated all round, styles connate .... 4. *W. deserticola*
8: Tepals not connate, not forming a cup-shaped tube, nectaries large, not elliptical, without elevated margins all round, styles not connate 9

9 Flowers moderately crowded, nectaries semi-oval, desert plants .... 2a. *W. centralis* ssp. *centralis*
9: Flowers well spaced, nectaries like broad ledges, southern plants .... 1. *W. biglandulosa*

Fig. 1. Habit of *Wurmbea* species (natural size). A, *W. biglandulosa* ssp. *flindersica* (*R. Bates 10264*); B, *W. dioica* ssp. *citrina* (*R.W. Rogers 464*); C, *W. decumbens* (*R. Bates 25630*); D, *W. dioica* ssp. *lacunaria*, male (*R. Bates 10483*); E, *W. latifolia* ssp. *latifolia*, male (*R. Copley 5213*); F, *W. latifolia* ssp. *vanessae*, male (*R. Bates 25606*); G, *W. stellata* (*R. Bates 19760*).

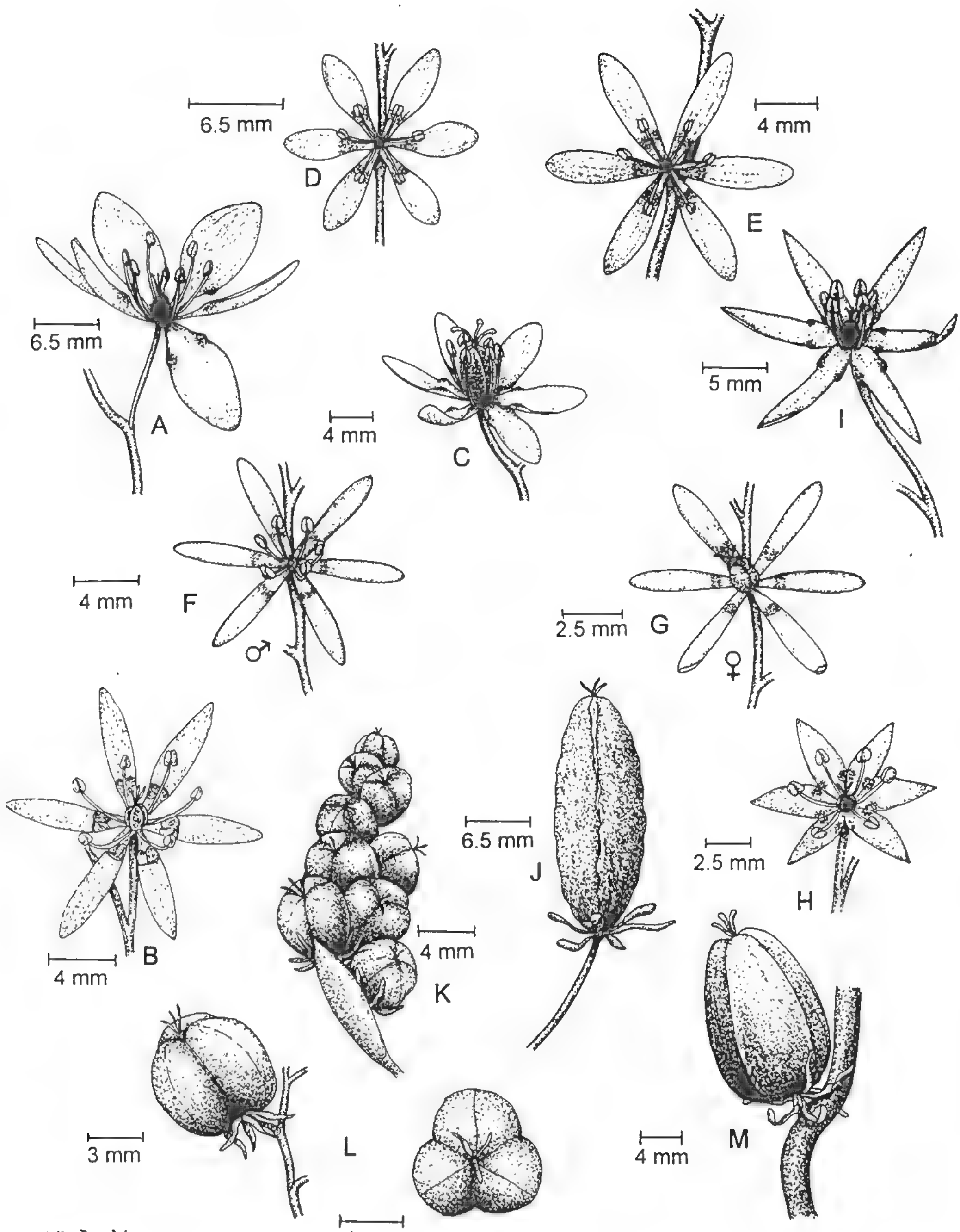


Fig. 2. A–I Flower. A, *Wurmbea biglandulosa* ssp. *flindersica* (*R. Bates 10264*); B, *W. centralis* ssp. *australis* (*R. Bates 40825*); C, *W. decumbens* (*R. Bates 28725*); D, *W. dioica* ssp. *citrina* (*R.W. Rogers 464*); E, *W. dioica* ssp. *lacunaria* (*R. Bates 10483*); F, G, *W. latifolia* ssp. *vanessae* (*R. Bates 25606*); F, male flower; G, female flower; H, *W. sinora* (*R. Bates 26263*); I, *W. stellata* (*R. Bates 19760*). J–M, Fruits. J, *W. decumbens* (*R. Bates 25672*); K, *W. dioica* ssp. *citrina* (*R. Bates 20788*); L, *W. latifolia* ssp. *latifolia* (*B. Copley 5213*); M, *W. latifolia* ssp. *vanessae* (*R. Bates 32462*).

1. Wurmbea biglandulosa (R. Br.)Macfarlane, Brunonia 3 (1980) 191; Fl. Austr. 45 (1987) 400.

Anguillaria biglandulosa R. Br., Prodr. 273 (1810).

Anguillaria australis F. Muell., Fragm. 7 (1870) 74, p.p., *nom. illeg.*

Melanthium brownii Schltdl., Linnaea 1 (1826) 86, p.p., *nom. illeg.*

W. biglandulosa has not previously been recorded for South Australia despite having been collected here over one hundred years ago and being locally common. The type form does not appear to occur here, and the South Australian plants are described as a separate subspecies.

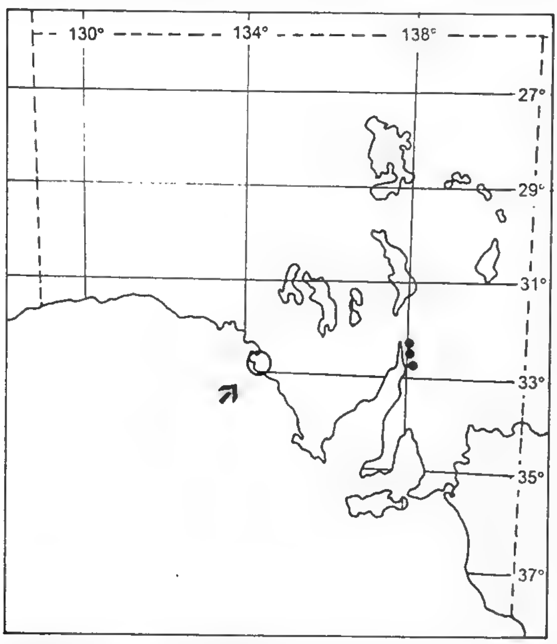
Key to subspecies

1 Uppermost leaf long, acuminate, flowers white, thin textured, nectaries clasping filaments (in living plants) .... 1a. ssp. *biglandulosa*
1: Uppermost leaf short, acute, flowers pink (at least outside) thick textured, nectaries not clasping filaments .... 1b. ssp. *flindersica*

1b. ssp. **flindersica** R. Bates, *ssp. nov.* (Figs 1A, 2A)

A ssp. *biglandulosa* habitu robusto, tepalis longioribus crassis roseis (non albis), nectariis filo non amplectantibus et foliis supremis brevior differt.

Type: On burnt ground, roadside opposite Army Camp at Hughes Gap (NL), 10.viii.1992, *A.G. Spooner 13351* (holo.: AD; iso.: AD, MEL, PERTH).



Map. 1. Distribution of *W. biglandulosa* ssp. *flindersica* ●, & *W. sinora* O in South Australia.

Plants moderately large, 5–30 cm tall. *Corm* ellipsoidal, 1.5–2 × 0.8 cm, 1–4 cm below ground. *Leaves* 3, well separated; lowest one basal, hardly dilated at base, linear, 5–15 cm long, 2–4 mm diam. at middle; middle leaf shorter dilated at base, upper portion long and tapering, filiform; uppermost leaf markedly dilated at base, with a short acuminate apex, attached well below the inflorescence. *Flowers* 2–6, all hermaphrodite. *Perianth* deep-pink outside, paler pink or white inside. *Tepals* 6, up to 12 mm long, shortly connate at base or free, segments narrow below nectaries, broader and spreading beyond, narrow elliptic. *Nectaries* 2 per tepal, brilliant carmine, situated 1/3 from base, in shallow pits, separated at the centre and reaching to margins, not clasping filaments. *Stamens* two thirds length of tepals,

filaments adnate to perianth only near base, not swollen. *Anthers* oblong, 2 mm long, versatile, attached at middle, deep purple-red. *Ovary* oblong, carpels sharply delimited from the free styles. *Capsules* dehiscing loculicidally. *Seeds* dark brown, 2 mm diam.

Distribution and ecology (Map 1)

Endemic to the southern Flinders Ranges from Gladstone north to Quorn, a distance of about 100 km. Common in open woodland dominated by *Eucalyptus cladocalyx* and *Callitris glaucophylla* usually on rocky slopes in fertile soils; in places forming a dominant ground cover after fire. Flowers: August to October; perfume – sweet, honey-like.

Distinguishing features

Easily recognised by the 2 large pink nectaries on each tepal. It can be separated from ssp. *biglandulosa* (which is confined to the Eastern States) by its pink rather than white flowers, the thick textured tepals with brilliant pink nectaries which do not clasp the filaments, and the shorter top-leaf. The 2 subspecies are separated geographically by over 500 km.

Variation: A rather constant taxon, varying only in number and size of flowers. In good seasons or after fires plants produce more and larger flowers.

Sympatric species

W. biglandulosa ssp. *flindersica* is often found with *W. centralis* but flowers 1–4 months later. Near Wirrabara it flowers together with *W. dioica* ssp. *dioica* in August and north of Melrose it occurs with *W. latifolia* ssp. *latifolia* in *Eucalyptus camaldulensis* woodland. Hybrids have not been recorded.

Etymology: As subspecies *flindersica* is only found in the Flinders Ranges the epithet is appropriate.

Conservation status: Common and well conserved throughout its range.

Notes

Macfarlane (1980, 84) did not record *W. biglandulosa* from South Australia. He identified some collections, i.e. 'H.M. Cooper Melrose' as *W. centralis* and his reference to pink flowered forms of *W. dioica* from South Australia may have been due to notes on collections of *W. biglandulosa.*

Both flies and native bees have been observed pollinating *W. biglandulosa* near Telowie Gorge.

Selected specimens seen (from c. 50 seen at AD)

SOUTH AUSTRALIA. FLINDERS RANGES: Alligator Gorge, 12.ix.1987, *R. Bates 10264*; Melrose, ix.1960, *H.M. Cooper s.n.*; Mt Remarkable, -.ix.1974, *H.M. Cooper s.n.*; Horrocks Pass, 29.xii.1922, *T.G.B. Osborne s.n.* (this bears the collector's label ... '*Anguillaria dioica* var. *hermaphrodita*'); Mambray Creek, -.x.1960, *J. Shillabeer s.n.*; On ridge N side of Mambray Creek, 5.ix.1974, *D.J.E. Whibley 4270*; N slopes of Mt Brown, 20.x.1958, *P.G. Wilson 623*. NORTHERN LOFTY: Telowie Gorge, 25.ix.1989, *R. Bates 20543*; Near the Bluff E of Port Pirie, 1.x.1978, *A.G. Spooner 6019*; 10 km N of Gladstone in Explosives Reserve, 7.ix.1991, *R. Bates 24865*.

2. **Wurmbea centralis** Macfarlane, Brunonia 3 (1980) 188; in Jessop, J.P. (ed.), Fl. Central Austr. 422 (1985); in Jessop, J.P. & Toelken, H.R. (eds), Fl. S. Austr. 4 (1986) 1772; Fl. Austr. 45 (1987) 395.

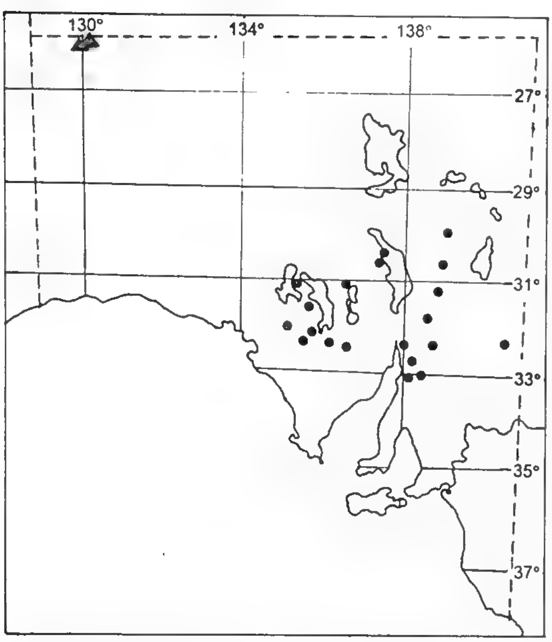
According to Macfarlane (1980) the type location of this species (Mt Olga) '... is far from the nearest South Australian locality.' and he predicted that it would occur in the Musgrave and Everard Ranges of South Australia.

Macfarlane's concept of *W. centralis* (1980, 1987) was very broad, he had seen no live material and included under *W. centralis* collections from as far afield as Kangaroo Island and the southern Flinders Ranges. He suggested (1980) that 'Study of living plants ...' might help resolve the true limits of the species. Field studies by the present author have shown that collections identified by Macfarlane as *W. centralis* actually represent at least 4 taxa. Tiny single flowered plants with narrow-linear leaves and decumbent scapes from Kangaroo Island and southern Eyre Peninsula belong to a distinct species described here as *W. decumbens*. Spring flowered plants from high rainfall areas of the Flinders Ranges with well spaced leaves belong to *W. biglandulosa* ssp. *flindersica* while winter flowering plants from southern, semi-arid South Australia with broad, flat, paired basal leaves and narrow tepals are here described as a separate subspecies *W. centralis* ssp. *australis*. Recent collections have increased the known distribution of *W. centralis* considerably.

Key to subspecies

1 Lower leaves basal and simiiar, broadly linear-lanceolate, not channelled; flowers usually less than 5, well separated, with narrow acute tepals; nectaries deeply pitted, clasping the filaments or not..... 2b. ssp. *australis*

1: Lower leaves well separated, dissimilar, linear, channelled above; flowers often more than 5, moderately crowded at least in early spike, with broad, rounded tepals; nectaries shallow, clasping the filaments at least in fresh flowers .... 2a. ssp. *centralis*



Map 2. Distribution of *W. centralis* ssp. *centralis* ▲, & *W. centralis* ssp. *australis* ● in South Australia

2a. ssp. **centralis.**

Plants large, 10–30 cm tall. *Corms* ellipsoidal, 0.5–2.5 × 0.3–1.5 cm, 5–18 cm below ground. *Leaves* 3, well separated, lowest leaf linear, thick and channelled, not inflated, to 20 cm long and 1 cm broad, suberect; middle one similar but with a dilated base; upper leaf dilated at the base with an acuminate apex to 5 cm long. *Flowers* 3–15, all hermaphrodite. *Perianth* pink, nectaries deeper pink. *Tepals* up to 8 mm long, shortly connate at the base, segments narrow below the nectaries, obovate beyond them, apex rounded. *Nectaries* 2 per segment, situated one-third from base of tepal, consisting of broad semi-oval ledges, separated at the centre, reaching the tepal margins, abruptly raised at their lower margins, clasping the filaments (not obvious in dried material where the nectaries resemble shrunken pouches). *Stamens* two-thirds as long as perianth, filaments adnate to tepals below nectaries, broad

near base but not grossly swollen. *Anthers* ovate, 1–1.5 mm long, versatile, attached at middle, purple-red. *Ovary* spherical, carpels sharply delimited from styles, styles free or basally connate. *Capsules* not seen.

Distribution and ecology (Map 2)

Only known from 3 sites in Central Australia, at the base of rocks near springs, i.e. Kata Tjuta (The Olgas) and in the Musgrave Ranges in far northern South Australia and near Wa Wee Waterhole in Western Australia. Flowers: May to September, depending on rainfall.

Distinguishing features

The long channelled leaves, and numerous, large, crowded pink flowers with rounded segments make this subspecies easy to separate from ssp. *australis*. It is closely related to *W. biglandulosa*, a spring flowered species which is much less robust and has a very different distribution and habitat.

Variation: A very constant taxon.

Sympatric species: The Helms collection below includes plants of *W. dioica* ssp. *citrina* which suggests the two were growing together. The Helms collection was from near Wa Wee Waterhole which is an Elder Expedition collection site in Western Australia.

Conservation status: Apparently rare but conserved in Uluru National Park.

Specimens examined (AD)

SOUTH AUSTRALIA. NORTH WEST: Upper Alalka Creek (Musgrave Ranges), 19.v.1983, *R. Bates 3073.*
WESTERN AUSTRALIA. Near Wa Wee Waterhole, 25.v.1891, *R. Helms s.n.*

2b. ssp. **australis** R. Bates, *ssp. nov.* (Fig. 2B)

A ssp. *centrali* foliis inferis latioribus ecanaliculatis confertis, tepalis angustis non rotundatis, nectariis fila nectariis amplectantibus differt.

Type: Siam Station, Gawler Ranges, on rocky hills of granite porphyry, 11.vii.1991, *R. Bates 25633* (holo.: AD, specimen A; iso.: AD, CANB, PERTH).

Plants robust, 7–20 cm tall. *Corms* spherical, 1.5–2.5 cm diam., dark brown, 3–10 cm below ground. *Leaves* 3, lowest 2 basal and similar, broadly linear-lanceolate, up to 10 cm long and 2.4 cm broad, leathery and often decumbent; the uppermost one distant from the base and markedly dilated, to 3 cm long with an acute apex. *Flowers* 1–5, all hermaphrodite, well spaced. *Perianth* pink, nectaries deeper pink. *Tepals* up to 12 mm long, shortly connate at the base, segments narrow below nectaries, narrow-elliptic beyond them, apex acute. *Nectaries* 2 per segment, situated less than one third above base of perianth, consisting of deeply pitted, semi-oval ledges, separated at the centre and reaching tepal margins, raised on lower margins, not clasping filaments. *Stamens* half as long as perianth, filaments adnate to tepals below nectaries, broader near base but not grossly swollen. *Anthers* ovate, 1–1.5 mm long, versatile, attached at middle, purplish. *Ovary* spherical, carpels sharply delimited from the styles, styles free. *Capsules* box-like, to 2.5 cm long (the largest of any Australian *Wurmbea*), dehiscence apical-loculicidal. *Seeds* dark, spherical.

Distribution and ecology (Map 2)

Endemic to arid or semi-arid South Australia, south of 29°S, mostly about rock outcrops, rarely along rocky ephemeral watercourses sometimes forming large dense populations in

the Gawler Ranges, sparse elsewhere. Flowers: May to August, depending on rainfall. The flowers are sweetly perfumed.

Distinguishing features

The broad, leathery leaves make *W. centralis* ssp. *australis* easily recognisable even when not in flower. The large bright pink, fleshy, narrow tepaled flowers, which open before other species in the same area, ensure it is not easily confused. The large papery seed capsules which open from the top and look like dried flowers rattle in the wind and allow identification even after the leaves have shrivelled. This subspecies appears very different from ssp. *centralis* in habit for that subspecies is a tall plant with long, narrow, channelled leaves, and somewhat crowded and more numerous flowers with broad, rounded tepals. The general flower morphology, size and colour are very similar and clearly indicate the relationship of the two taxa which are geographically separated by several hundred kilometres of desert.

Variation: Most variation is due to climatic conditions; after a wet autumn flowering is abundant, leaves and flowers are larger than usual. Plants from the Flinders Ranges are sometimes smaller in all their parts.

Sympatric species

W. centralis ssp. *australis* has been observed growing with *W. dioica* ssp. *citrina* in rocky places in the northern Flinders Ranges, and the Plumbago Hills; it commonly occurs with *W. dioica* ssp. *dioica* on the edges of rock outcrops in the Gawler Ranges and in the mid Flinders Ranges; in the southern Flinders Ranges it grows with *W. biglandulosa* ssp. *flindersica* and with *W. stellata* near Mt Ive Station in the Gawler Ranges. Near Melrose it occurs within a few hundred metres of *W. latifolia,* the two flowering together. No hybrids have been noted.

Etymology: The epithet *Australis* (L.), southern, refers to the more southerly distribution of the subspecies.

Conservation status: Common and well conserved particularly in the Flinders and Gawler Ranges.

Notes

Macfarlane (1980) determined collections from southern Eyre Peninsula and Kangaroo Island as *W. centralis* but these plants are here treated as a separate species (*W. decumbens*). Macfarlane's description (1980, 1987) of *W. centralis* is very broad and covers at least 4 taxa treated in this paper.

Selected specimens (from 37 seen at AD)

SOUTH AUSTRALIA. LAKE EYRE: Terrapinna Springs, far Northern Flinders Ranges, 2.vii.1988, *R. Bates 14727*. GAIRDNER-TORRENS: Andamooka Is., Lake Torrens, 14.vi.1989, *K. Bellchambers & G. Carpenter 2818*; Eucola Ck. near Woomera, 17.viii.1974, *F.A. Mason 63*. FLINDERS RANGES: Mt Falkland, 17.vi.1959, *E.N.S. Jackson 90*; Wilpena Pound, 6.ix.1961, *D.E. Symon 1363*. EASTERN: NE Plumbago Stn, 11.vi.1989, *R. Bates 18805*. EYRE PENINSULA: Nonning, 20.ix.1973, *T. Reichstein 1582*. NORTHERN LOFTY: Telowie Gorge, 5.v.1980, *R. Bates 12354*.

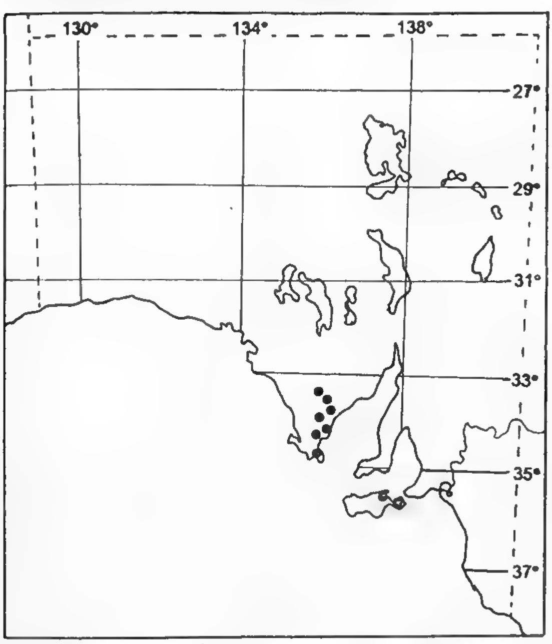
3. **Wurmbea decumbens** R. Bates, *sp. nov.* (Figs 1C, 2C, J)

A *W. centrali* foliis longis angustis decumbentibus, flore minuto singulo, scapo decumbente, capsulis elongatis differt.

Type: Darke Range, Eyre Peninsula, 10.vii.1991, *R. Bates 25672* (holo.: AD, specimen A; iso.: AD, CANB, PERTH).

Plants to 8 cm high. *Corms* ellipsoidal, 1.5–2 × 0.8 cm, 1–5 cm below ground. *Leaves* 3, lower leaves both basal and similar, flaccid, decumbent, narrow-linear, pale green, 5–20 cm long, 0.2–0.5 cm wide, not dilated at base; upper leaf ovate, short, inflated, bract-like, acute, to 1 cm long. *Scape* very much shorter than leaves, 3–9 cm long, green, filiform, at first erect but becoming decumbent soon after anthesis. *Flower* single rarely 2, very small, hermaphrodite. *Perianth* cup-shaped, to 7 mm across, white, often turning purple with age. *Tepals* 6, narrow-elliptic, often irregular in size and shape, 3–5 mm long and 1–1.5 mm wide, free or partly conjoined basally; nectaries 2 per tepal, concolorous with the tepals, about 2 mm diam., situated just below the tepal midpoint, marginal, pitted, with small auricles projecting from the outer margins. *Stamens* 2 mm long, filament adnate to tepal for 0.5 mm, not swollen at base. *Anthers* ovate, 1 mm long, versatile, attached at middle, purple. *Ovary* oblong, carpels sharply delimited from the free styles. *Capsule* to 2 cm long and 1 cm wide after flowering, dehiscing loculicidally. *Seeds* spherical, orange, roughened, to 1.2 mm diam.

Distribution and ecology (Map 3)



Map 3. Distribution of *W. decumbens* in South Australia.

While endemic to South Australia, it is widespread and locally common on Eyre Peninsula but rare on Kangaroo Island. Rarely collected until 1991 when the author found it on numerous rocky hills on central Eyre Peninsula, mostly on sheltered southern slopes at the base of rocks. Flowers: May to July, perfume faintly lemon-scented.

Distinguishing features

W. decumbens is a distinctive species recognised by the long narrow decumbent leaves, the tiny, usually single flower and the large elongated seed capsule on its decumbent scape. Its closest ally is probably *W. sinora* Macfarlane, which differs in having the lower leaves spaced and erect not paired and decumbent. *W. sinora* also does not have such a large seed capsule and the scape remains erect. Both species do have a single tiny flower with winged outer margins to the nectaries. Macfarlane (1980) determined collections of *W. decumbens* as probable depauperate forms of *W. centralis* but did (p. 198) note their similarity to *W. sinora.*

Variation: A very constant species and not likely to be confused with any others.

Sympatric species

W. dioica ssp. *dioica* was present at all the known sites of *W. decumbens* and the two flower at the same time but no hybrids were seen. Near Koppio *W. decumbens* grows with *W. latifolia* ssp. *vanessae* again with an overlap in flowering times but without hybrids.

Etymology: The epithet *decumbens* (L.), refers to the decumbent leaves and scape.

Conservation status: Most of the known populations are in reserves. Suggested conservation status – 3RC.

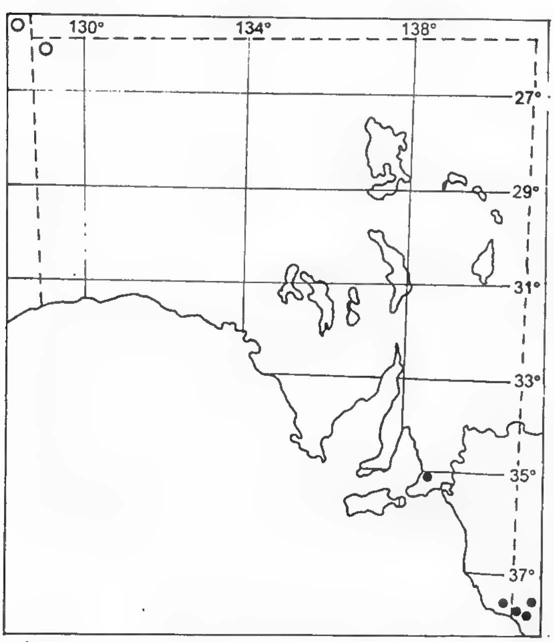
Notes

W. decumbens is locally common at several well botanised sites, the probable reason for the lack of collections is the early flowering time, the small size and the generally held belief that all *Wurmbea* in the area would be the common *W. dioica*. From observations of cultivated plants it would seem that flowers are self pollinated or perhaps apomictic as all flowers set large seed capsules even though anthers remain intact.

Selected specimens (from 15 seen at AD)

SOUTH AUSTRALIA. EYRE PENINSULA: Caralue Bluff, 10.vii.1991, *R. Bates 25630*; Hillock by the pump station, 7 km N of Tumby Bay, 9.vii.1991, *R. Bates 25599*; Wharminda Soak, 9.vii.1991, *R. Bates 25595*; Flinders Monument, Lincoln Conservation Park, 9.vii.1991, *R. Bates 25609*; Carrapee Hill, 28.ix.1989, *R. Bates 20813* (in seed). KANGAROO ISLAND: Council quarries, Kingscote, 17.vii.1963, *G. Jackson 258*.

4. **Wurmbea deserticola** Macfarlane, Brunonia 3 (1980) 185; in Jessop, J.P., (ed.), Fl. of Central Austr. 422 (1985); Fl. Austr. 45 (1987) 398.



Map 4. Distribution of *W. deserticola* O and *W. uniflora* ● in South Australia.

Plants large, 7–25 cm tall. *Corm* ellipsoidal, 1–2 cm long, buried 10–16 cm below ground level. *Leaves* 3, lower one basal, broad-linear, more than 3 mm broad, to 20 cm long, channelled above, not dilated at base; middle leaf set well above basal one, much shorter, markedly dilated at first with a long tapering apex to 10 cm; uppermost one much shorter, dilated basally, apex short, acute, set well below inflorescence. *Flowers* (1) 3–11 in an open spike, all hermaphrodite. *Perianth* pink, nectaries deeper pink. *Tepals* 6, to 15 mm long, connate for one third their length to form a cup-shaped tube, connecting tissue between tepal bases thin, segments broad-elliptical, apex rounded. *Nectaries* 2 per tepal, situated near margins of segments slightly above top of tube and clasping filaments, consisting of raised narrow-elliptical areas, all margins distinct and raised. *Stamens* over half length of tepals,

filaments adnate to base of tepals, not swollen basally. *Ovary* spherical, carpels sharply delimited from the styles; styles connate up to half their length. *Capsules* globose to 1 cm diam. *Seeds* brown spherical, 2 mm diam.

Distribution and ecology (Map 4)

Widespread in desert areas of Western Australia and the Northern Territory. Recently recorded for South Australia, apparently rare in red sand dunes or rocky places near water. Flowers: May to August, depending on rain.

Distinguishing features

The tall stems with well-spaced, large, pink, hermaphroditic flowers and the conjoined styles make this an easily recognised species. The only *Wurmbea* throughout most of its range.

Sympatric species: Not recorded as growing with any other species.

Conservation status: Not known but probably more widespread than the sparse collections indicate. It is likely to be found in the Simpson Desert Regional Park or the Great Victoria Desert, both vast areas poorly botanised.

Specimens examined (AD)

SOUTH AUSTRALIA: NORTH -WESTERN: In clay-sand by rocks near Pipalatjara Camp, 7.v.1980, *C. Aitken s.n.*

5. **Wurmbea dioica** (R. Br.)F. Muell., Fragm. 10 (1877) 119; Macfarlane, Brunonia 3 (1980) 159–165; G.R. Cochrane et al., Fl. Pl. Victoria & Tasmania 71 (1980) t. 321; Macfarlane in Jessop, J.P., & Toelken, H. (eds.) Fl. S. Austr. 4 (1986) 1772; Fl. Austr. 45 (1987) 389.

Anguillaria dioica R. Br., Prodr. 273 (1810); J. Black, Fl. S. Austr. edn 1 (1922) 106; edn 2 (1943) 186.

This is by far the commonest and most variable species in South Australia. Macfarlane (1980) noted that there were several forms in South Australia, with flowers of different colour and morphology but stated that having not studied living material from this State he was not in a position to subdivide the species.

Field studies have shown that there are 3 subspecific taxa within *W. dioica* in South Australia, each with a discrete geographical range and specific habitat.

Key to subspecies

1 Flowers yellow-green, perianth thick textured, seed capsule globose, not ribbed, desert plants .... 5b. ssp. *citrina*

1: Flowers cream, white, or tinged pink, perianth thin textured, capsule oblong, ribbed 2

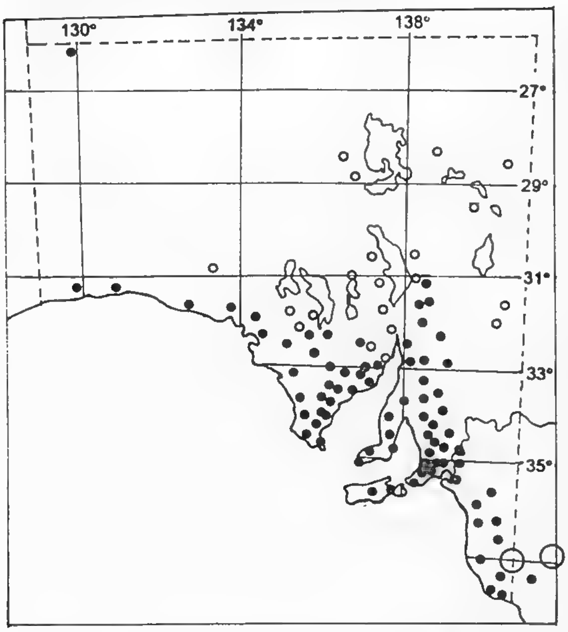
2 Semi-aquatic plants, usually over 20 cm tall, flowers cream coloured, nectaries pale greenish, anthers yellow .... 5c. ssp. *lacunaria*

2: Not aquatic, less than 20 cm tall, flowers white or tinged pink, nectaries purplish, anthers purple-red .... 5a. ssp. *dioica*

5a. ssp. **dioica.**

Plants small to moderately small, up to 20 cm tall. *Corm* spherical to ellipsoidal, 0.5–1.5 cm diam., to 5 cm below ground. *Leaves* 3, well spaced; lowest one basal, not or slightly dilated basally, filiform or narrow linear, channelled, to 10 cm long and to 1.5 mm broad; middle leaf shorter, dilated at base with a long tapered filiform or linear apex; uppermost leaf variable but smaller than middle one, attached well below inflorescence in some forms, just below in others, with tapering upper part short or long. *Flowers* (1) 2–5 (7), plants dioecious, female plants generally with larger flowers. *Perianth* white with purple nectaries, sometimes tepal edges purple or whole flower purple in the red-stemmed forms. *Tepals* 4.5–10 mm long, connate only at base, segments ovate to obovate. *Nectary* situated one third from base of tepal, consisting of a continuous transverse flat band, not folded around filament. *Stamens* about half as long as tepals, filaments adnate to perianth only near the base, broader toward base but not swollen; in female flowers absent or present only as short or long filaments. *Anthers* ovate, oblong, sharply delimited from the free styles. *Capsule* ovoid, dehiscing loculicidally. *Seeds* brown, spherical, c. 1 mm diam., several per locule.

Distribution and ecology (Map 5)



Map 5. Distribution of *W. dioica* ssp. *dioica* ●; *W. dioica* ssp. *citrina* O and *W. dioica* ssp. *lacunaria* ◯.

Widespread and common in a range of habitats throughout southern parts of the State within the 250 mm isohyet; in forest, woodland, grassland, rock outcrops, mallee and mallee-heath. Flowers: June to November, in dense scrub flowers well only after bushfires. Perfume indistinct, floral.

Distinguishing features

The thin-textured, white, dioecious, sexually dimorphic flowers with purple nectaries in a transverse band, the well spaced leaves with swollen bases and angular ribs on the seed capsules are all features of this variable taxon.

Variation: There are several distinct, habitat specific forms with discrete distribution which can be recognised even from dried material. In areas of high rainfall, i.e. the southern Flinders Ranges, Mt Lofty Ranges and lower South-East, in acid soils, plants have a long acuminate apex to the top leaf, the flowers moderately large with no pink tints. This is the type form common in the Eastern States. In drier, plains areas, often in calcareous or alkaline soils i.e. Eyre Peninsula, Yorke Peninsula, the Adelaide and Murray Plains plants have a short top leaf, often with smaller flowers and sometimes with pink tints. In the dry, granite country of the Gawler Ranges, in fertile loams, plants have filiform leaves, small flowers, the female ones particularly, turning purple-pink with age.

Sympatric taxa

W. dioica ssp. *dioica* has been found growing in the same areas as all other South Australian *Wurmbea* species except *W. deserticola.*

Conservation status: Abundant and well represented in many Conservation Parks.

Selected specimens (from 60 seen at AD)

SOUTH AUSTRALIA. NULLARBOR: 78 km E of W.A. border, on edge of Highway, 8.viii.1989, *E.M. James 80*. GAIRDNER-TORRENS: Moonaree, on red sands by rocks, 11.vii.1991, *R. Bates 25641*. FLINDERS RANGES: Floor and sides of Wilpena Pound, 16.ix.1960, *D.E. Symon 7471*. EASTERN: Hills NE of Oodlawirra, 9.vii.1988, *R. Bates 14565*. EYRE PENINSULA: On red sandy by Caroona-Siam road, 11.vii.1991, *R. Bates 25640*; S Port Neill, 19.vii.1965, *C.R. Alcock 669*. NORTHERN LOFTY: Spring Gully Conservation Park, 26.viii.1980, *E.N.S. Jackson 3785*; Near the King Tree, Wirrabara, 10.ix.1989, *R. Bates 20497*. MURRAY: 15 km SW of Purnong, 11.viii.1963, *Hj. Eichler 17206*; 28 km N of Keith in sand, 25.viii.1961, *P.G. Wilson 1975*. YORKE PENINSULA: Near Daley Head, 27.viii.1976, *B. Copley 4971*; The Pines via Corny Point in dry sand, 2.viii.1987, *R. Bates 10084*. SOUTHERN LOFTY: Anstey Hill, 21.viii.1983, *A.G. Spooner 8735*; Mile End Railway Line (Adelaide Railway Station), 19.viii.1928, *E.H. Ising s.n.*. KANGAROO ISLAND: On cliffs between Kingscote and Brownlow, 10.ix.1988, *G. Jackson 41*. SOUTH-EASTERN: Mt Macintyre, 20.x.1989, *R. Bates 21239*.

5b. ssp. **citrina** R. Bates, *ssp. nov.* (Figs 1B, 2D, K)

A ssp. *dioica* tepalis rotundatis crassis citrinis, capsulis sphaericis ecostatis differt.

Type: Common at Lake Eyre South in low sandhills, 9.vi.1978, *F.J. Badman 61* (holo.: AD, specimen A; iso.: AD.)

Plant slender to robust, often dwarfed, 2–30 cm tall. *Corm* large, ellipsoidal, 2–3 × 1–2 cm, deeply buried, 5–35 cm below ground and covered in numerous, black, parchment-like sheaths. *Leaves* 3, well spaced, leathery, lowest one basal, linear-lanceolate, erect, base not inflated, 5–10 cm long, about 3–15 mm diam.; middle leaf shorter, erect, inflated at base, with a long tapering apex; uppermost leaf very short, greatly inflated at base, acuminate, erect. *Flowers* several to many (-15), plants strongly dioecious, sexually dimorphic, male flowers larger, fewer, with narrower tepals, female flowers more rigid, spike often flexuose. *Perianth* yellow-green, thick textured, with greenish-brown nectaries. *Tepals* ovate-elliptic, 7–8 × 3–4 mm, connate at base. *Nectary* situated about one third from base of tepal, a continuous, transverse, hardly raised green-brown band, not clasping the filaments. *Stamens* half as long as perianth, filaments adnate only at base, not swollen, present in male flowers only. *Anthers* ovate, 1.5 mm long, purple-brown. *Ovary* globose, on female plants only, capsule with rounded segments which are not ribbed, splitting sepicidally. *Seeds* dark brown, spherical c. 1.2 mm diam.

Distribution and ecology (Map 5)

Widespread and common throughout arid South Australia and western New South Wales in a variety of habitats but especially in shallow sand overlying fertile clays. Ssp. *citrina* replaces ssp. *dioica* throughout most of its range. Flowers: May to September, depending on rainfall. Perfume faint, floral.

Variation: Size and number of flowers is dependent on seasonal conditions. In deeper clay soils flowers seem to be a brighter green, the tepals glossy and leaves particularly broad.

Sympatric species

For most of its range *W. dioica* ssp. *citrina* is the only *Wurmbea* present but it has been collected with *W. centralis* on several occasions usually flowering slightly later, it occurs

within a few hundred metres of *W. stellata* near Mt Finke and in the Gawler Ranges and in the latter area within 1 km of *W. dioica* ssp. *dioica*. Intermediates have not been noted.

Etymology: The epithet *citrina* (L.) citrus- or lemon-coloured, alluding to the striking greenish-yellow flowers unique in this genus in Australia.

Conservation status: A common taxon in South Australian deserts and probably well conserved.

Notes

The ssp. *citrina* does not intergrade with ssp. *dioica*, in fact inland populations of ssp. *dioica* are less similar to it than southern populations as they have slender leaves, narrow perianth and pink tinted flowers. Further research may show that ssp. *citrina* may be better treated as a separate species. Ssp. *citrina* is very drought tolerant, occurring in areas receiving less than 125 mm rain a year., i.e. in the driest part of the continent. The deeply buried corms suggest that this taxon may avoid droughts by not sprouting unless good rains occur.

Selected specimens (from c. 40 at AD)

SOUTH AUSTRALIA. LAKE EYRE: Cooper Creek crossing on Birdsville Track, 10.vi.1979, *B. Crisp 580*; Boorthanna on railway , sandy ground, 1954, *T.R.N. Lothian 39*; 150 km NW of Marree on road to Oodnadatta, *J.Z. Weber 767*; 2 km N of Stuart Creek, opal fields on sandplain at edge of claypan, 25.vi.1989, *F.J. Badman 2863*. GAIRDNER-TORRENS: Interdune swales on clay near Mt Finke, 30.viii.1976, *R. Bates 100*; Andamooka Island, Lake Torrens saltpan, 14,vi.1989, *K. Bellchambers & G. Carpenter 2758*; Sand dunes, NE corner of Lake Gairdner, 6.vii.1971, *B. Lay 330* ('bulbs over 30 cm from surface'). FLINDERS RANGES: Brachina Track W of Gorge, 17.vii.1988, *K. Alcock 19*; Moralana Station, 12.vii.1987, *D.E. Symon 14652*. EASTERN: Cathedral Rock, Old Boolcoomatta, 10.vi.1989, *R. Bates 20788*; 5 km NNW of Strathearn Stn. on edge of claypan, 22.vii.1978, *L.D. Williams 9960*. EYRE PENINSULA: Southern shores of Lake Acraman, in red sandy loam on plain, 26.ix.1989, *R. Bates 20788* (in seed).

5c. ssp. **lacunaria** R. Bates, *ssp. nov.* (Figs 1D, 2E)

A ssp. *dioica* foliis longis, spicis longis, floribus cremeis nectariisque pallidis, antheris flavis differt.

Type: Waterholes NE of Goroke on road to Desert Lodge, western Victoria, 15.x.1991, *R. Bates 26010* and *Vanessa* (holo.: AD, specimen A; iso.: AD, BM, CANB, MEL).

Plant tall, slender, 10–40 cm high. *Corm* ellipsoidal, 1.2–2.0 × 1.0–1.5 cm, shallowly buried, dark brown. *Leaves* 3, linear, channelled, widely spaced, very erect, lowest one basal, base not inflated, 10–30 cm long, 3–5 mm diam., middle leaf similar but inflated at base, longer to 35 cm, uppermost leaf similar to others but more distinctly inflated at base, apex long and tapered. *Plants* strongly dioecious, the sexes similar. *Flowers* (1) 3–15, well spaced in a long narrow spike. *Perianth* cream coloured, drying yellowish, thin textured, with pale nectaries. *Tepals* elliptic, 8–12 × 3–4 mm, free. *Nectary* one third from base, a continuous transverse hardly raised band of pale green or brown, not clasping the filaments. *Stamens* about half as long as tepals, adnate to segments for lowest 1 mm, broader towards base but not swollen; in female flowers absent or present only as short filaments. *Anthers* ovate, to 2 mm long, versatile, attached at middle, yellow not red. *Ovary* ovoid, sharply delimited from the free styles. *Capsule* oblong, ribbed, septicidal. *Seeds* brown, spherical, c. 1 mm diam., several per locule.

Distribution and ecology (Map 5)

So far only known from a few seasonal waterholes in *Eucalyptus camaldulensis* woodland, in water to 50 cm deep, in the far South East of South Australia and western

Victoria. Most such waterholes have been badly damaged by stock and do not contain any *Wurmbea*. Flowers Late September to November. Fragrance sweet-floral.

Distinguishing features

The tall spikes, long leaves, cream coloured flowers, pale nectaries, yellow not red anthers, and the unusual habitat make this an easily recognised taxon.

Variation: Very constant over its limited range.

Sympatric taxon

W. dioica ssp. *dioica* occurs in woodland within 100 m of ssp. *lacunaria* but the two do not intergrade.

Etymology: The epithet *lacunaria* (L.), lagoon, in reference to the habitat of this taxon.

Conservation status: Highly localised and poorly conserved. Suggested status 2EC.

Notes

This is the only semi-aquatic *Wurmbea* in Eastern Australia, although there are several taxa in Western Australia from similar habitats. The lowest leaf is often rotted away at flowering. In wet years flowering is delayed until water levels fall below 30 cm. In drought years when waterholes remain empty flowering does not occur.

Specimen examined (AD)

SOUTH AUSTRALIA. SOUTH-EASTERN: Waterhole off Mi Mia Mia Road North of Bangham, 25.ix.1988, *R. Bates 15625*.

6. **Wurmbea latifolia** Macfarlane, Brunonia 3 (1980) 170; in Jessop, J.P. & Toelken, H. (eds.) Fl. S. Austr. 4(1986)1772; Fl. Austr. 45 (1987) 394.

There are two distinct forms of this species in South Australia. The type form with very short, broad leaves, the lower two strictly paired and basal and with very short flower spikes, the capsules globose and flowers in May to July; a second more widespread form with longer, narrower leaves, basal two not always paired and taller flower spikes, the seed capsules ovoid, flowers in July to September. The two have separate ranges and are treated here as distinct subspecies.

Key to subspecies

1 Basal leaves opposite, < 10× as long as wide, female flower spike dense and hardly exserted from the leaves,
globose capsule ~~glabrous~~ .... 6a. ssp. *latifolia*

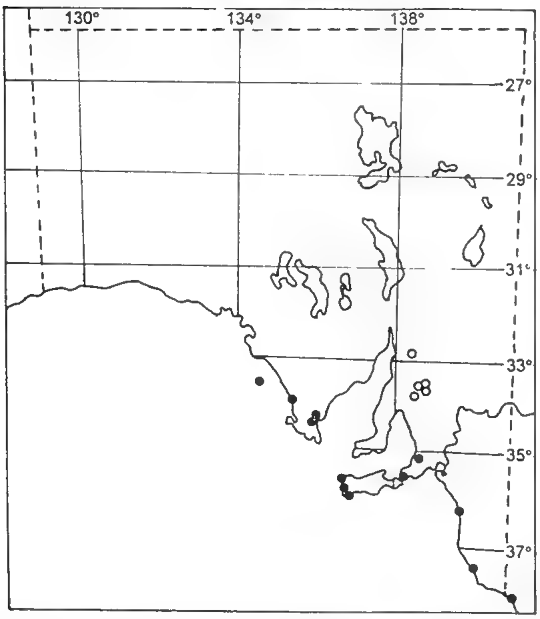
1: Basal leaves not opposite > 10× as long as wide, female flower spike not dense, exserted on a scape at least 2 cm long, capsule oblong .... 6b. ssp. *vanessae*

6a. ssp. **latifolia**. (Figs 1E, 2L)

Plants small but stout, generally less than 8 cm tall. *Corm* spherical, 1–2 cm diam., 2–4 cm below ground level. *Leaves* 3, the lower 2 similar, almost opposite, basal, with serrate margins, lanceolate to broad-lanceolate, to 8 cm long and 6–12 mm broad, with the inflorescence almost concealed between them, the upper leaf very short, lanceolate, just below or partly concealed within inflorescence. *Flowers* 2–6, dioecious, sexually dimorphic; females small, rounded, hidden at base of leaves; males larger more angular,

exserted from leaf-base. *Perianth* white, nectary pale. *Tepals* 4–6 mm long, connate at base, segments narrow-ovate, shorter and broader on female plants. *Nectary* about 2 mm from base of tepal, a narrow, continuous, semi-circular ridge, slightly thicker toward the tepal margins. *Stamens* 3–4 mm long, the filaments slightly thicker toward base. *Anthers* ovate, 1.3 mm long, purple, attached at middle. *Ovary* globular, sharply delimited from the free styles. *Capsule* dehiscing loculicidally. *Seeds* dark-brown, 1.5 mm diam., spherical.

Distribution and ecology (Map 6)



Map 6. Distribution of *W. latifolia* ssp. *latifolia* O and *W. latifolia* ssp. *vanessae* ● in South Australia.

Endemic to the northern Mt Lofty Ranges and adjacent Flinders Ranges in heavy, often waterlogged soils of open forest and woodland, not coastal. Flowers: June, July; fragrance faint, floral.

Distinguishing features

A very distinct taxon because of the short, broad, almost opposite basal leaves, the short dense female flower spike often partly concealed in the basal leaves, the pallid sexually dimorphic flowers and the globose seed capsule.

Variation: This is a very constant taxon.

Sympatric species: Near Mt Remarkable *W. latifolia* ssp. *latifolia* occurs near *W. centralis* and near Brinkworth with *W. dioica* ssp. *dioica* without intermediates.

Conservation status: 2VC. Small populations occur in the Mt Remarkable National Park, a heritage reserve near Koolunga and a water reserve at Bundaleer.

Specimens examined (AD)

SOUTH AUSTRALIA. FLINDERS RANGES: Melrose Flats, Mt Remarkable National Park, 14.vii.1991, *R. Bates 25675*. NORTHERN LOFTY: Pedlers Heritage Scrub via Koolunga, 31.viii.1992, *R. Bates 28986*; Bundaleer Reservoir, 31.vii.1992, *R. Bates 28976*; Barunga Gap Rail Reserve, 12.vi.1967, *B. Copley s.n.*; Georgetown, 1839, *Richardson s.n.*; Roadside N Brinkworth, 24.vi.1978, *A.G. Spooner 5820*; Yackamoorundie Range, in shallow soil among rocks, 24.vi.1978, *A.G. Spooner 5831*.

6b. ssp. **vanessae** R. Bates, *ssp. nov.* (Figs 1F, 2F, G, M)

A ssp. *latifolia* foliis angustioribus latius dispositis, spicis longis, floribus majoribus nectariis coloratis capsulisque elongatis differt.

?Anguillaria dioica R. Br. var. *multiflora* J.D. Hooker, Fl. Tasmania 2 (1858) 46.

Type: Deep Creek Conservation Park, South Australia, on windswept headlands, 4.viii.1991, *R. Bates 26207* (holo.: AD, specimen A; iso.: AD, HO, MEL).

Plants small, 5–12 cm tall. *Corm* spherical, 1–2 cm diam., black, about 3 cm below ground level. *Leaves* 3, lower 2 similar, close together or separated by up to 2 cm, broadly linear, 5–10 cm long, 1.5–8 mm broad, with serrate margins; lowest one basal, not dilated; middle leaf slightly more erect and sometimes dilated basally; upper leaf smaller, inflated at base with a short acuminate erect apex. *Flowers* 3–7, plants dioecious, the inflorescence open and well above the basal leaves. *Perianth* white or pink, nectary variable in colour, sometimes concolorous with tepals more often coloured greenish to deep purple. *Tepals* 6–9 mm long, connate only at the base. *Nectary* 2 mm from base of tepal, either a narrow continuous ridge, thicker toward tepal margins, or more often with a narrow break at centre. *Stamens* 4 mm long, filaments adnate to tepal base, and broader near base. *Anthers* ovate, 1–1.2 mm long, attached at middle, purple-brown. *Ovary* oblong, sharply delimited from the free styles. *Capsule* dehiscing loculicidally. *Seeds* brown, 1.5 mm diam., several per locule.

Distribution and ecology (Map 6)

Widespread along the coast and offshore islands from Eyre Peninsula, Fleurieu Peninsula, Kangaroo Island, and the South-East of South Australia, extending into Victoria and ?Tasmania. Occurs in low scrub on exposed sites such as headlands, stabilised sandhills, windswept islands and cliff faces, more rarely up to 20 km inland. Flowers: July to September, which is later than for ssp. *latifolia*. Fragrance strong, sweet.

Distinguishing features

Despite being more closely related to *W. latifolia* ssp. *latifolia* it is easy to confuse with *W. dioica* ssp. *dioica*. From the former it differs in the narrower leaves, taller, more slender flower spikes, oblong seed capsules, and later flowering; from the latter in having the lower leaves similar, less tapering, with serrate margins and floral nectaries often separated in the middle.

Variation: More variable than the type subspecies, particularly in regard to position of the lower leaves, which may be almost opposite or not, and in length of scape, flower shape and colour of nectaries. It is possible that some of this variation is due to introgression with *W. dioica* ssp. *dioica*.

Sympatric species

Often found with *W. dioica*, less commonly with *W. decumbens*, flowering times do overlap and introgression may occur with *W. dioica* ssp. *dioica*. Occurs within 100 m of *W. uniflora* near Mt Richmond (Vic.) but the flowering times do not overlap.

Etymology: Named after Vanessa, my wife and companion on field trips.

Conservation status: A taxon of sporadic occurrence but locally common and well conserved. It is certainly more widespread and common than the few collections suggest.

Notes

Further work is required to show the relationship between *W. latifolia* ssp. *vanessae* and Tasmanian and New South Wales plants, referred to *W. latifolia* by Macfarlane (1980). It may later be found that island and mainland plants belong to different subspecies.

Specimens examined (AD)

SOUTH AUSTRALIA. EYRE PENINSULA: Freeling Is. (St Francis group), 10.vi.1975, *Dr N. Wace 489*; Section 108, Hundred of Koppio, 10.ix.1966, *C.R. Alcock 1290*; 1.3 km W of Tod Reservoir near Port Lincoln (with *W. dioica* and *W. decumbens*), 9.vii.1991, *R. Bates 25606*. SOUTHERN LOFTY: Mt Bold Reservoir cliffs, 22.viii.1983, *R. Bates 3222*. KANGAROO ISLAND: Near the Ravine de Casoars, in limestone under mallee,

10.x.1992, *R. Bates 29418*; Cape Du Couedic lighthouse, 22.viii.1982, *E.N.S. Jackson 4380*. SOUTH-EASTERN: Coorong National Park, in red sandy soil, 19.viii.1983, *M.B. Thompson 23*; Little Dip Conservation Park, 5.xi.1983, *E.N.S. Jackson 4856*.

VICTORIA: Portland, Discovery Bay above Whites Beach, 12.viii.1956, *A.C. Beauglehole 19532*.

7. **Wurmbea sinora** Macfarlane, Brunonia 3 (1980) 196; Fl. Austr. 45 (1987) 401. (Fig. 2H).

Plant small, slender 3–8 cm tall. *Corms* ovoid, black, to 1 cm diam. *Leaves* 3, well spaced, lowest one filiform, not or scarcely dilated at base, erect, to 10 cm long; middle leaf shorter, markedly dilated at base with a long filiform upper portion; upper leaf markedly dilated at base with a short acute or acuminate apex, attached well below inflorescence. *Flowers* 1–3, usually 1 in South Australian populations, hermaphrodite. *Perianth* white, nectaries white. *Tepals* c. 5 mm long, sepals 6, connate only at base, narrow below nectaries lanceolate above. *Nectaries* 2 per tepal, situated 1 mm from base of tepal, consisting of well separated marginal, winged or shelf-like thickenings, lower and outer margins distinct, upper ones indistinct, tepals clasping filaments. *Stamens* c. 3 mm long, filaments adnate in lower part, not swollen. *Anthers* shortly ovate, 0.5 mm long, versatile, attached near middle, dark purple. *Ovary* globose, carpels sharply delimited from the free styles. *Capsules* ovoid, to 0.8 mm long. *Seeds* spherical, brown 0.5 mm diam.

Distribution and ecology (Map 1)

Known with certainty only from one site in South Australia but probably more widespread on Eyre Peninsula. Certainly recorded from over a wide range in Western Australia where it favours rock outcrops and ephemeral drainage lines. Flowers: July, August.

Distinguishing features

The small stature, single, tiny, white flower, with winged nectaries and purple anthers, together with late winter flowering time set the latter apart from all species except *W. decumbens*, which differs in having long, paired, decumbent, not filiform, basal leaves, and decumbent scape as well as very long seed capsule and has finished flowering before *W. sinora* begins to bloom.

Variation: South Australian material matches very well with collections from east of Esperance in Western Australia.

Conservation status: 2E in South Australia. Not conserved. Sporadic and uncommon in Western Australia.

Notes

This species has not previously been recorded for South Australia. It is locally common on the coast and sometimes inland, from the Fitzgerald River to Twilight Cove in Western Australia. In South Australia it has so far only been found in sand, near granite outcrops close to the coast of Eyre Peninsula.

Macfarlane (1980) noted the similarity of 'forms of *W. centralis*' from Eyre Peninsula to *W. sinora*, but did not cite collections. It is likely these plants were *W. decumbens* or *W. sinora* and not *W. centralis*.

Specimens examined (AD)

SOUTH AUSTRALIA. EYRE PENINSULA: Rocks near Murphy's Haystacks, 25.viii.1983, *R. Bates 6529*; 1 km E of Murphy's Haystacks, 19.vii.1988, *C. Peters 311*.

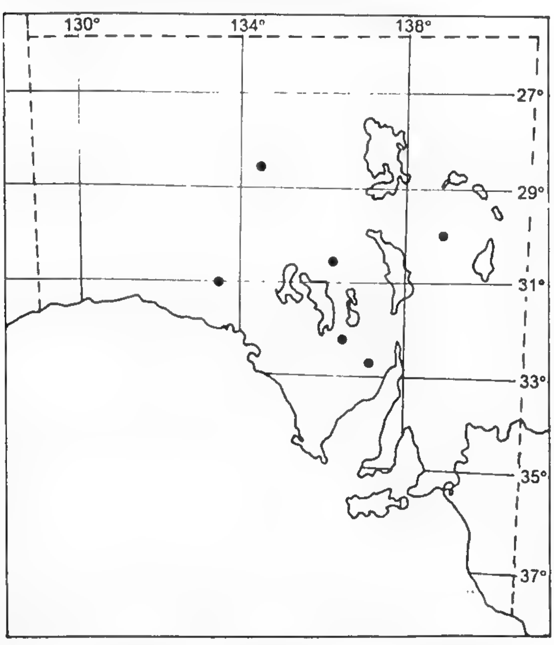
8. **Wurmbea stellata** R. Bates, *sp. nov.* (Figs 1G, 2I)

A *W. centrali* foliis scapisque angustis et purpuris, floribus singulis stellatis bicoloribus tepalis angustis rigidis et nectariis saccatis angustis differt.

Type: Caroona Hill (EP), on rocky slope of gorge in red clay amid low mallee, 7.vii.1991, *R. Bates 25542* (holo.: AD, specimen A; iso.: AD, BM, CANB, MEL, PERTH).

Plants slender, purplish-green, to 10 cm tall. *Corm* ovoid, 1–2 cm long, black, 3–8 cm below ground level. *Leaves* 3, lower 2 well separated, upper 2 close together, lowest leaf filiform to linear, channelled, 4–10 cm long, base purple, not dilated, apex lax or decumbent, internode 2–3 cm; 2nd leaf linear, 1–2 cm long, dilated basally; uppermost leaf small just below the flower, dilated basally, ovate, acute. *Flower* usually single, hermaphrodite, widely expanding, starry, large for size of plant. *Perianth* white, usually with bright purple-pink margins, nectaries concolorous. *Tepals* 6, free from the base, narrow elliptic, 7–8 mm long, 2–3 mm broad, acute, with thickened margins; nectaries 2 per tepal, situated about 1 mm from tepal base, narrow oval, longitudinal, pouch-like, very close to tepal margins, all margins distinct and raised. *Stamens* 4 mm long, falcate, with inflated bases adnate to the tepals, pink or white. *Anthers* oblong, 1 mm long, versatile, attached below middle, purple. *Ovary* oblong, carpels sharply delimited from the 1.5 mm long styles. *Capsule* ovoid, to 1 cm long, loculicidal. *Seeds* spherical, c. 1 mm diam., dark brown.

Distribution and ecology (Map 7)



Map 7. Distribution of *W. stellata* in South Australia.

Endemic to South Australia, in arid or semi-arid areas westward from the Flinders Ranges to the Great Victoria Desert and south to the Gawler Ranges, growing in red clay soils on plains or rocky hills, often in exposed sites free of other vegetation. Flowers: June to July. Fragrance sweet, floral.

Distinguishing features

The narrow, purple-tinted leaves and stem, the closely spaced upper leaves, the single, star-like, bicoloured flowers, with their narrow rigid tepals, thickened margins and narrow, concolorous, pouched, marginal nectaries make this a very distinct species.

Variation: Plants from northern plains have broader leaves and larger nectaries.

Sympatric species

In the Gawler Ranges it commonly occurs with *W. dioica* ssp. *dioica* and *W. centralis* and their flowering times overlap. Hybrids have not been noted but some of the features of the Gawler Ranges race of *W. dioica* ssp. *dioica* may be derived from influence of *W. stellata* i.e. the filiform, purplish, basal-leaf and purple tinged tepals. On inland plains it sometimes occurs near or with *W. dioica* ssp. *citrina.*

Etymology: The epithet *stellata* (L.), starry, alluding to the flat star-like flowers.

Conservation status: Widespread, but highly localised and never occurring in large numbers. As it is not known from any conservation park its suggested rating is 3R.

Notes

Macfarlane (1980) makes no reference to this taxon, he apparently did not see any material of it.

Specimens examined (AD)

SOUTH AUSTRALIA. NORTH-WESTERN: N Marla, on sandy-clay flats between hills, 5.vii.1989, *R. Bates 19760.* LAKE EYRE: 50 km S Coober Pedy, on red sandy-clay flats, 3.vii.1989, *R. Bates 18931.* GAIRDNER-TORRENS: Mt Finke, on lower slopes, 15.vi.1987, *P. Canty 1445.* FLINDERS RANGES: 20 km E of Mt Lyndhurst, low stony hills in *Maireana astrotricha* low shrubland, 17.vi.1988, *J. Reid 1443.* EYRE PENINSULA: 25 km W of Mt Ive, 27.vii.1968, *J.Z. Weber 1201*; specimens labelled A & B on sheet of *W. dioica.*

9. **Wurmbea uniflora** (R. Br.)Macfarlane, Brunonia 3 (1980) 194; in Jessop, J.P. & Toelken, H. (eds.), Fl. S. Austr. 4 (1986) 1773; Fl. Austr. 45 (1987) 402.

Anguillaria uniflora R. Br., Prodr. 273 (1810).

Anguillaria australis F. Muell., Fragm. 7 (1870) 74 p.p., *nom. illeg.*

Plants small, 4–14 cm tall. *Corm* ovoid, c. 1 cm long, 2–3 cm below ground level. *Leaves* 3, well spaced; lowest one narrow-linear, to 10 cm long, 1.5–2 mm broad at middle, not dilated at base; middle one shorter, filiform or narrow-linear, dilated at base; uppermost one much shorter with markedly dilated base and a short to long acuminate apex, attached well below inflorescence. *Flowers* usually single, rarely 2, facing upward, hermaphrodite. *Perianth* usually white, faintly purple tinged with age or less often bright pink from anthesis, nectaries concolorous with perianth 5–7 mm long. *Tepals* 6, shortly connate or free from base, segments elliptic to oblanceolate, apex acute to slightly rounded. *Nectaries* 2 per segment, situated just below middle of tepal, consisting of well separated, marginal, longitudinally extended, thickened ledges, the lower and lateral margins distinct and slightly raised, the upper margin indistinct, tepal folded around filament so that a nectary lies on either side of it. *Stamens* greater than half length of tepals, filaments adnate to perianth below nectaries not swollen at base. *Anthers* ovate, 1 mm long, versatile, attached at middle, yellow. *Ovary* oblong, carpels sharply delimited from the free styles which are often recurved. *Capsule* ovoid to 1 cm long. *Seeds* brown c. 0.8 mm long.

Distribution and ecology (Map 4)

Probably extinct in the Mt Lofty Ranges and known from a single site in the South East but locally common in a variety of habitats particularly in fertile red loams in forest or woodland in southern and eastern Victoria and Tasmania, probably extinct in New South Wales.

Distinguishing features

Not likely to be confused with any other species due to its late flowering and tiny flowers with yellow anthers and uncoloured nectaries. Single flowered specimens of *W. dioica* have sometimes been confused with *W. uniflora* but these do not have hermaphrodite flowers and their nectaries are most unlike those of *W. uniflora.*

Variation: A very constant taxon varying only in size of plant and flower colour.

Sympatric species

Growing in the same area as *W. dioica* in South Australia and *W. latifolia* ssp. *vanessae* in south-western Victoria.

Conservation status: 3E, known only from a single population of less than 10 plants on a fire break.

Notes

Macfarlane (1980) suggested that this species may have become extinct in South Australia. It does seem highly unlikely that it still occurs in the Mt Lofty Ranges but it has been recently located in the south-east of South Australia and is common in Victoria's Glenelg River National Park adjacent to the South Australian border. Macfarlane notes that the flowers are white but there are pink flowered forms, especially along the Lower Glenelg River.

Specimens examined

SOUTH AUSTRALIA. SOUTHERN LOFTY: Clarendon, on black, moist soil, near the (Onkaparinga) River, 28.x.1881, *J.G.O. Tepper s.n.* (MEL). SOUTH-EASTERN: Mt Macintyre summit, 7.xi.1980, *R. Bates 7890* (AD).

VICTORIA. (Near South Australian border) Glenelg River National Park, in red loams, 16.x.1991, *R. Bates 26040 & Vanessa* (AD).

Unplaced specimens

Larger populations will need to be found and studied in the field before the status of the following collections can be ascertained.

SOUTH AUSTRALIA. LAKE EYRE: 39 km SW Murnpeowie on low stony slopes, 15.viii.1968, *D. Symon 5613*. Most of the plants on this sheet resemble *W. centralis* but the lower leaves do not appear opposite. One flower has the characteristics of *W. deserticola.*

SOUTH AUSTRALIA. EYRE PENINSULA: Pine Lodge, Gawler Ranges, 25.ix.1989, *R. Bates 21483*. This single plant has several tiny, white flowers with nectaries as for *W. sinora*, but the leaves are as for *W. dioica.*

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TAXONOMY AND EVOLUTION OF *SENNA OBTUSIFOLIA* AND *S. TORA*

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Abstract

The relationship between *S. obtusifolia* (L.)Irwin & Barneby and *S. tora* (L.)Roxb. is discussed. Consideration of biogeography suggests that the latter species evolved in Asia from the former.

Taxonomy

Both *S. obtusifolia* and *S. tora* are weedy in northern Australia and many other areas in Asia and the Pacific. Their relationship has become an important facet of a project to investigate biological agents for their control.

It is universally acknowledged that the taxa are very closely related, with strong similarities in gross morphology (Brenan 1958, De Wit 1955, Randell 1988), ecological requirements (Ablin 1990), and seed chemistry (Randell unpubl.). The constant differences between them are few and relatively minor, involving seed and anther morphology (De Wit 1955, Brenan 1958, Randell 1988), seed weight (Randell unpubl.), vegetative characters (Singh 1968), and epidermal features (Mathur 1985, cited in Vatsavaya & Rama Rao 1986).

S. obtusifolia is commonly, perhaps always, self-pollinated before the flower opens (Irwin & Barneby 1982). The two forms are not known to hybridise in the field (Randell unpubl.) but are interfertile in experimental crosses (Irwin & Turner 1960). There is a suggestion that they flower at different times (Vatsavaya S. Raju & N. Rama Rao 1986).

Taxonomically, there are 3 possible ways to describe the relationship between the two forms.

1. They are the same species (e.g. Bentham 1871, Irwin & Barneby 1982).
2. They are different species (e.g. Linnaeus 1753, De Wit 1955, Randell 1988).
3. They are infraspecific taxa within the same species (Haines 1922).

It may be significant that, virtually without exception, those who placed the names in synonymy worked in America or Europe, where only herbarium material was available. Workers in Asia, with access to living material, uniformly maintained that two taxa of at least varietal level were involved. However, all these judgements were based solely on morphological evidence.

Evolution of the taxa

In evolutionary terms, the very close relationship between the taxa could be explained in several ways; viz. 1. *S. obtusifolia* may have evolved from *S. tora*; 2. *S. tora* may have evolved from *S. obtusifolia*; or 3. both taxa may have evolved from a common ancestor.

Consideration of the biogeography of the two taxa may help decide which is the most likely hypothesis.

Currently, *C. tora* occurs on the Indian continent (Vatsavaya & Rama Rao 1986); in Thailand (Smitinand *et al.* 1984); New Guinea (Verdcourt 1979); Malaysia (De Wit 1955); Java (Backer & van den Brink 1963); and (rarely) in Australia [Pt Darwin, N.T., 1888; Milla Milla, Qld, 1952 (Randell 1988)].

C. obtusifolia is distributed in India (Singh 1968); Philippines (Irwin & Barneby 1982: 254); more rarely in Java (Backer & van den Brink 1963) and New Guinea (Verdcourt 1979); it is common in the southern United States north to North Carolina and Missouri (Isley 1975); through Mexico and Central America, circum-Carribean; in South America from Colombia through Brazil to Paraguay and Argentina (Irwin & Barneby 1982: 253); and also from "Uganda, Kenya, Tanganyika and Zanzibar" in Africa (Brenan 1958).

However, this detailing of the current distribution gives no indication of the original boundaries of distribution, nor of how much of the current situation is due to human activity. For example, it is known that *S. obtusifolia* has reached Australia only in recent years, but it is now becoming alarmingly common in coastal areas of north Queensland, around Cooktown, Cairns and Mackay (Ablin 1990).

Both species are placed in the South American series *Trigonelloideae*, a group of 9 species, of which 7 are restricted to the Americas, one (*S. obtusifolia*) is very widespread and almost pantropical, and one (*S. tora*) is extra-American in distribution (Irwin & Barneby 1982, though *S. tora* is not covered in this revision).

Within the series, *S. obtusifolia* is part of a closely related group also including the weedy *S. cobanense* and the rare and localised *S. pentagonia*, which "probably originated by mutation from the common sickle-pod (i.e. *S. obtusifolia*) or an immediate ancestor" (Irwin & Barneby 1982: 256).

S. obtusifolia occurs in the core distribution area of the series (South America). It is "phenetically heterogenous" with three chromosome races (n=12, 13, 14) (Irwin & Barnby 1982). It shows a variety of inherited growth forms (Irwin & Turner 1960). Its seed germination is tolerant of a wide range of temperatures (Singh 1968). Thus *S. obtusifolia* is a variable taxon, and it is not unlikely that it has given/will give rise to further new forms.

S. tora occurs outside the core distribution area of the series (i.e. from India, to China and the Philippines). Phytochemical studies have shown that compounds present in *S. obtusifolia* are absent in *S. tora* (Upadhyaye & Singh 1986, cited in Ablin 1990). It shows a narrower tolerance for variation in seed storage temperatures (Singh 1968). These descriptions all refer to a relatively stable taxon.

Thus it is very unlikely that *S. tora*, relatively invariable and outside the core distribution area, gave rise to *S. obtusifolia*, highly variable and within the core distribution area. Hypothesis 1 can be discarded.

So it is probably that *S. tora*, like *S. cobanense* and *S. pentagonia*, evolved from *S. obtusifolia* or from an *S. -obtusifolia*-like ancestor.

There was probably a common ancestor of *S. obtusifolia* and the other 7 taxa currently occurring in South America. However, there is no evidence that any such taxon ever existed outside South America.

If *S. tora* had evolved in Central America, we would expect to find records of its occurrence in either America or Africa. Irwin & Barneby (1982: 254) confirm that it is "foreign to the New World", and Brenan cites only a single doubtful specimen of *S. tora*

from Africa (1958: 251). Its absence from both those areas indicates that it probably evolved in Asia.

It would then be impossible for *S. tora* to evolve in Asia, from an *S. obtusifolia-like* ancestor which never occurred outside South America. Hypothesis 3 becomes very improbable.

Could *S. tora* have evolved in Asia from *S. obtusifolia*? (hypothesis 2). This is certainly possible.

Senna obtusifolia does occur in areas where *S. tora* is distributed i.e. in India and southern Asia. The first record of the occurrence of *S. obtusifolia* in India is that of Roxburgh (1832 as *S. toroides*), who reported seeds of the plant being collected in Mysore in 1800. Apparently, the first collection of true *S. tora* was made in Sri Lanka by Paul Hermann, definitely before 1695 (his death) and probably before 1680 (when he took up a professorial chair in Europe) (Stafleu & Cowan 1979).

Then the most probable of our three hypotheses is that *S. tora* evolved in Asia from plants of *S. obtusifolia*. Perhaps *S. tora* is a race of *S. obtusifolia* that was produced by a rare mutational event, and, if both are self-pollinated, is reproductively isolated from its parent.

Irwin & Barneby (1982) recognise that *S. obtusifolia* is not uniform. It may be possible to determine which variant of it gave rise to the taxon now known as *S. tora*.

There are two major variants of *S. obtusifolia* in the Americas, differing primarily in pod type. Plants from "the Antilles and the United States" have broader pods, 3.5–6 mm in diameter, as do African specimens, and those from India, Indo Malaya and China (Irwin & Barneby 1982: 254). It seems likely that material of this variant was transported from the Americas to Africa and thence to Asia. Irwin & Barneby also discuss this possible expansion.

Conversely in most other areas of South America, the pod is narrower (2–3.5 mm diam.) and strongly curved. Populations in the Philippines are of this type, and probably represent a separate later introduction of the narrow-podded variant, (Irwin & Barneby 1982) perhaps from the west coast of Mexico.

Indian workers diligently searching for characters useful in distinguishing the two taxa have never mentioned pod width. We may then infer that *S. tora* strongly resembles the Indian populations of *S. obtusifolia* in pod diameter. *S. tora* is generally described as having pod diameters of 5 mm (Smitiland *et al.* 1984 for Thailand; De Wit 1955 for Malaysia) 4–6 mm (Symon 1966 for Australia) or 2–5 mm (Randell 1988 for Australia). Thus it is probable that it was derived from an ancestor like the broad-podded form of *S. obtusifolia* from "the Antilles and the United States."

Biological studies (e.g. enzyme analyses or DNA studies) are needed, to confirm the suggestion that *S. tora* is derived from the broad-podded variant of *S. obtusifolia*.

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NOTES ON *HIBBERTIA** I. NEW TAXA FROM SOUTH-EASTERN AUSTRALIA

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Abstract

The new combination *Hibbertia incana* (Lindley) Toelken is made. The following taxa are described and illustrated, their affinities discussed and distribution outlined: *H. cistiflora* N.A. Wakef. subsp. *rostrata* Toelken, *H. humifusa* F. Muell. subsp. *debilis* Toelken and subsp. *erigens* Toelken, *H. obtusibractea* Toelken, *H. pallidiflora* Toelken, *H. sessiliflora* Toelken, *H. tenuis* Toelken & R. Bates, *H. torulosa* Toelken.

The compilation of *Hibbertia* for the Flora of Victoria has prompted a reassessment of a number of taxa. Only a few could be adequately evaluated in the limited time available to publish new taxa. Other known variants need much more field work to assess their full variation and taxonomic status. It is hoped that the publication of these taxa will encourage more discriminate collecting in this complex genus where species are known to consist of often numerous disjunct populations comprising local variants of the taxon more or less isolated variants. The revisor cannot possibly hope to explore the full distribution range of each species but equally cannot assess the taxonomy without knowledge of that range of variation. Consequently a full re-evaluation cannot be attempted at present of larger species complexes, such as *H. riparia*, throughout their wide range of much of temperate south-eastern Australia. Species from Victoria are particularly difficult to evaluate because most of at least the older names are based on specimens collected in central New South Wales, Tasmania or South Australia, so that one is rarely dealing with the typical form, and, if so, then it is often one of several forms in Victoria.

Three rare species endemic to South Australia are also described because here as in Victoria their conservation may depend on taxonomic recognition. More research time has been given to their discrimination to help their conservation.

Without entering into detailed discussions of the inflorescences found in *Hibbertia* only one foliage organ immediately below the terminal flower is always called a 'bract'. Rarely few similar bracts are found next to one another. Other leaves lower down which might be modified to enhance the inflorescence, such as the often very much broadened leaves below the inflorescence of *H. incana* are then referred to as 'bract-like leaves' as opposed to 'leaf-like bracts', which are relatively large bracts that are similar to foliage leaves.

The terms 'central vein' and 'central ridge' for a structure at a similar position on the abaxial leaf surface are not used interchangeably. The latter is used for a much enlarged structure incorporating the relatively small vein being only a small part of it. In this way structural information is reflected in the terminology. The central ridge and/or the revolute margins are often unequally swollen so that their relative level to one another was found to present a reliable characteristic of many taxa when taken at the middle of mature cauline leaves.

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Hibbertia cistiflora N.A. Wakef., Victorian Naturalist 72: 119 (1955).

Pleurandra cistiflora Sieber ex Spreng., Syst. Veg. 4, Curae Posteriores 191 (1827), nom. illeg., non Rchb. (1825).

Type: Australia, *F.W. Sieber* in Sieber's 'Flora Novae Hollandiae No. 148' (holo.: B n.v. but probably destroyed; iso.: G, MEL).

Hoogland (1983) has already pointed out that Wakefield's name for the species must be treated as a *nomen novum* because it is based on the illegitimate name, *Pleurandra cistiflora* Sieber ex Spreng. (cf. Art. 58, Greuter et al. 1994).

This species is distinguished from all other similar members of the *H. riparia* complex by the hairs, if present, usually being simple, and the glabrous carpels each with the style attached to the dorsal side and not the apex as in the latter species.

Key to subspecies

1. Leaves with apex obtuse to acute, usually somewhat recurved, with central ridge raised above narrow revolute margins, covered with tubercle bases (or with hairs when young) mainly along the margins .... 1a. subsp. *cistiflora*

1: Leaves with apex drawn into blunt beak, stiffly erect, with central ridge recessed or rarely at the same level as revolute margins and with tubercle bases (without hairs) on most parts of leaves .... 1b. subsp. *rostrata*

1a. subsp. **cistiflora**.

Spreading to decumbent shrublets, with glabrous, usually wiry branches to 0.4 m long. *Tomentum* of tubercle-based hairs each with rarely more than 1 branch but wearing off soon, mainly on leaves. *Leaves*: *lamina* linear to linear-lanceolate (1.7-) 2.5–5 (-8.6) × (0.4-) 0.5–0.8 (-1.1) mm, obtuse often becoming rounded, with central ridge scarcely protruding beyond the apex and recurved when young, above with scattered simple hairs or their tubercle bases mainly along the margin, below with broad central ridge raised high and protruding beyond the revolute margins and usually without hairs or tubercle bases. *Flowers* sessile, terminal on some branches but not on short shoots.

Distribution and ecology

Growing in heath or woodland often associated with sandstone outcrops in central New South Wales (CC, CT).

Voucher specimens

NEW SOUTH WALES: *Central Tablelands*: *E.F. Constable NSW 43105* (CANB, NSW); *R.D. Hoogland 12256* (CANB; HBG, K, L, NSW, UC n.v.).

1b. subsp. **rostrata** Toelken, *subsp. nov.*

A subsp. *cistiflora* foliorum apicibus extensis in rostris et dorsis centralibus recessis differt.

Type: Victoria, The Grampians, Victoria Range, c. 3 miles S of Goat Track, *R.D. Hoogland 11889*, 20.ix.1970 (holo.: CANB; iso.: MEL, NSW; B, HBG, K, L, UC, US n.v.)

Spreading to scrambling shrubs 0.2–0.6 (-1.5) m tall, with glabrous, woody to rarely wiry branches when scrambling. *Tomentum* papillose representing tubercle bases of hairs that are only visible on the beak of young leaves. *Leaves*: *lamina* linear, (4-) 6–12 (-14.5)× 0.5–1 (-1.2) mm, tapering into a beak (0.1-) 0.2–0.5 mm long (straight or curved upwards when

Fig. 1. A–C, *Hibbertia cistiflora* subsp. *rostrata*. A, flowering branch; B, cauline leaf from below; C, transverse section at middle of cauline leaf (*R.D. Hoogland 11896*). D, *H. humifusa* subsp. *humifusa*, flowering branch (*H.R. Toelken 8362*). E, - subsp. *erigens*, flowering branch (*R. Thomas 583*). F, - subsp. *debilis*, flowering branch (*A.C. Beauglehole 38020*). G–I, *H. incana*. G, flowering branch; H, cauline leaf from below; I, transverse section at middle of cauline leaf (*Ackland 12*). K,L, *H. sericea* var. *sericea*. K, cauline leaf from below; L, transverse section at middle of cauline leaf (*Cowle MEL 35676*).

young) and formed by the protruding central ridge, with scattered tubercle bases on both surfaces, below with narrow revolute margins raised and protruding beyond the recessed broad central ridge. *Flowers* sessile, terminal mainly on short shoots with up to 8 reduced leaves. Fig. 1A–C.

Distribution and ecology

Found in heath or scrub vegetation, rarely in rock outcrops at high altitude and usually well above the forested areas of the Grampians, Victoria.

Voucher specimen

VICTORIA: *Grampians*: *R.D. Hoogland 11893* (CANB, MEL; BRI, HBG, L, UC n.v.).

Notes

In very exposed situations the plants are usually rigid spreading shrubs to 25 cm high with most flowers terminal on branches. Mainly when plants are scrambling in other vegetation the branches are more wiry with many apparently axillary flowers sessile on short shoots along the elongated branches. In both growth forms the leaves of this subspecies are found along the branches in contrast to the typical subspecies, where they are often clustered at the end of each branch. However, occasionally the leaves are also clustered towards the end of branches in subsp. *rostrata* in plants growing under what seem to be exposed conditions.

The epithet 'rostrata', beaked in Latin, refers to the beaked leaves.

Hibbertia humifusa F. Muell., Pl. Victoria 1: 16, suppl. t.1 (1862).

Type: Victoria, 'in barren shrubby plains near Mount Zero', Nov. 1853, *F. Mueller MEL 1010248* (lecto.: MEL, selected here; syn: MEL 1010247, MEL 1010249, MEL 1010250).

Perennials with prostrate to decumbent branches up to 0.4 m long, usually much branched, with pubescent to glabrescent wiry branches. *Tomentum* of tubercle-based stellate hairs (rarely locally absent) under simple hairs on branches, leaves and sepals. *Leaves* with axillary tuft of hairs 0.3–1.2 mm long; *petiole* often indistinct, 0.2–0.6 mm long; *lamina* linear-elliptic rarely -lanceolate, (3.5-) 5.4–9 (-14)× 0.9–3 mm, gradually constricted into blunt rarely acute apex with a tuft of more or less well developed simple hairs and into short petiole, above convex and pubescent often becoming glabrous, below with narrow recurved margins scarcely raised above narrow central vein on exposed undersurface usually stellate-tomentose together with more or less simple hairs. *Flowers* with peduncle 0–24 mm long and turning downwards after flowering, terminal on main shoots or rarely on short shoots, with one rarely two bracts 2.2–3.7 mm long and borne in different positions varying from the base of the peduncle to below the flowers. *Sepals* 3.3–9.4 mm long but enlarging after flowering, acute to acuminate, outside more or less densely covered with stellate hairs under usually coarse, few to many simple hairs, inside usually pubescent with stellate and/or simple hairs. *Petals* obovate to oblanceolate, 5.8–12.4 mm long, bright yellow. *Stamens* 6–10 in one cluster; *filaments* usually free; *anthers* oblong, truncate above and below. *Carpels* 2, tomentose, each recurved with style attached to the upper third of dorsal apex.

Notes

This variable species is fully described here because it is no longer construed in a narrow sense as the typical subspecies. The range of variation observed in the limited material of subsp. *humifusa* from the Grampians represents that of isolated populations of a more

widespread species fragmented by its specific habitat requirements, so that the other two subspecies recognised here are seen as extreme forms presumably isolated for a long period of time from the geographically central population. The type from near Mt Zero (northern Grampians) is much closer to subsp. *erigens* and subsp. *debilis* in its sparser tomentum, and the smaller flowers borne usually on longer peduncles, than populations from near Stawell (mid-eastern Grampians). It would be desirable to relocate plants of this population in order to evaluate how closely its range of variation would resemble that of the geograpically isolated subspecies. All attempts to do this have failed. It is, however, significant that plants from the isolated populations of subsp. *humifusa* from near Heathcote are almost indistinguishable from those from near Stawell.

Key to subspecies

1. Outer sepals 3.5–5.8 mm wide .... 1a. subsp. *humifusa*
1: Outer sepals 1.3–3 mm wide:
2. Sepals 4.2–7.5 mm long; stellate hairs scattered on branches .... 1b. subsp. *erigens*
2: Sepals to 3.6 mm long when flowering; stellate hairs usually absent from branches .... 1c. subsp. *debilis*

1a. subsp. **humifusa**.

Perennial with prostrate branches to 0.4 m long and with stellate and simple hairs. *Peduncle* 0.5–8 mm long when flowering, stiff, with single bract borne usually on upper half. *Outer sepals* ovate, 5.2–7.8 mm long, 3.5–5.8 mm wide, densely covered with stellate and coarse simple hairs. Fig 1D.

Distribution and ecology

Growing usually on sandy to sandy-clay soil but often near temporary moist places and usually associated with woodland, mainly on lower slopes of and the plains surrounding the Grampians, but has also been recorded from near Heathcote.

Voucher specimens

VICTORIA: *Grampians*: *A.C. Beauglehole 49799* (CANB, MEL); *Midlands*: *A.C. Beauglehole 64997* (MEL).

1b. subsp. **erigens** Toelken, *subsp. nov.*

A *H. humifusa* subsp. *humifusa* sepalis exterioribus angustioribus pilis simplicibus paucis et saepe pedunculis longioribus; a subsp. *debili* sepalis exterioribus longioribus et latioribus et saepe pedunculis longioribus differt.

Type: Victoria, Western Interchange, Euroa, *R. Thomas A*, 5.x.1992 (holo.: AD; iso.: K, MEL).

Perennial with decumbent branches to 0.25 m long and with stellate and simple hairs. *Peduncle* 4–25 mm long when flowering, thread-like, with single bract borne on lower third. *Outer sepals* lanceolate, 4.2–7.5 mm long, 1.9–3 mm wide, covered sparsely to densely with stellate hairs under scattered simple hairs. Fig. 1E.

Distribution and ecology

Growing on sandy loam in open vegetation often associated with woodland of *Eucalyptus blakelyi*, *E. macrorhyncha*, *E. melliodora* and *E. microcarpa* of central Victoria.

Voucher specimens

VICTORIA: *Midlands*: *R. Thomas 583* (MEL); *Riverina*: *D.G. Cameron s.n* (MEL).

Notes

The epithet 'erigens', rising in Latin, refers to the erect flowers on their slender peduncles which give them in the low grass of their habitat the impression of a rising star on the horizon.

1c. subsp. **debilis** Toelken, *subsp. nov.*

A *H. humifusa* subsp. *humifusa* sepalis exterioribus brevioribus angustioribusque et pilis stellatis paucis in ramis; a subsp. *erigenti* sepalis exterioribus brevioribus et angustioribusque et pedunculis brevioribus differt.

Type: Victoria, near Dergholm, *A.C. Beauglehole 38020*, 7.12.1971 (holo.: MEL; iso.: CANB, HO).

Perennial with decumbent branches to 0.2 m long with simple or rarely stellate hairs below flowers. *Peduncle* 4–7 mm long when flowering, thread-like, with 1 or 2 bracts borne at the base or lower third of the peduncle. *Outer sepals* lanceolate, 3.3–3.6 mm long, 1.3–1.5 mm wide, sparsely covered with stellate hairs under scattered simple hairs. Fig. 1F.

Distribution and ecology

Known only from the type collection from wet heathland near Dergholm and urgently in need of conservation.

Notes

The subsp. *debilis* is the smallest of the three subspecies and hence the choice of the epithet 'debilis', delicate or weak in Latin.

Hibbertia incana (Lindley) Toelken, *comb. nov.*

Pleurandra incana Lindley in T. Mitch., Three Exped. Australia 2: 156 (1838).

Type: Victoria, Mt Hope, *T.L. Mitchell 204*, 28.vii.1836 (holo.: CGE n.v.;iso.: MEL).

H. stricta (R. Br. ex DC.) F. Muell. var. *canescens* Benth., Fl. Austr. 1: 27 (1863); J.M. Black, Fl. S. Austr. 2 edn, 3: 576 (1952); S.J. Forbes et al., Cens. Vasc. Pl. Vic. 48 (1984).

Type: as for *P. incana.*

H. sericea sensu Benth., Fl. Austr. 1: 26 (1863), pro parte; sensu Willis, Handb. Pl. Victoria 2: 390 (1972), pro parte; sensu Beadle, Stud. Fl. N.E. New South Wales 3: 255 (1976), pro parte; sensu Beadle et al., Fl. Sydney Region 3 edn, 228 (1982); sensu Jessop in Jessop & Toelken, Fl. S. Austr. 1: 357 (1986), pro parte; sensu Harden & J. Everett in Harden, Fl. New South Wales 1: 302 (1990), pro parte - non Benth., Fl. Austr. 1: 26 (1863).

Spreading shrubs 0.2–1.5 (-2) m tall, often much branched. *Tomentum* of fine tubercle-based hairs consisting of dense stellate hairs each with 2 to many branches and above them more or less dense long silky hairs, on branches, leaves and sepals. *Leaves* with axillary tuft of hairs 0–1.2 (-1.8) mm long; *petiole* indistinct, 0–0.6 mm long; *lamina* of cauline leaves linear to linear-triangular or rarely linear-elliptic, (3.2-) 5.2–13.5 (-22.4)× (1.2-) 1.7–2.5 (-4) mm, obtuse or rounded with pointed to rounded apex of central ridge touching but rarely protruding beyond apex, abruptly constricted into petiole, above convex and stellate-tomentose appearing velvety under usually long silky hairs which soon wear off, below with central ridge usually much broader than but often not touching revolute margins and stellate-tomentose like above. *Flowers* sessile, in terminal clusters of 1–7 (-12) flowers by sympodial growth on main branches and usually more or less surrounded by broadened

bract-like leaves and subtended by smaller leaf-like bracts 3.4–8.2 mm long and with recurved margins. *Sepals*: outer ones oblong-lanceolate, obtuse with recurved margins at least at the apex, 5.3–11.1 mm long, tomentose outside and usually about two-thirds of inside; inner ones oblong ovate, rounded to cuspidate and with more or less membranous margins, 4.8–8.4 mm long, tomentose outside and sometimes the margins inside, pale green. *Petals* usually broadly obovate, 5.4–13.6 (-15.3) mm long, bright yellow. *Stamens* (8-) 10–14 (-16) in one cluster; *filaments* free or basally connate; *anthers* oblong, truncate at apex and base. *Carpels* 2, short-velvety to woolly, recurved with erect styles attached to dorsal apex. Fig. 1H–G.

Distribution and ecology

Recorded from a wide range of vegetation including scrub, woodland and forest but often associated with granite outcrops. Known from New South Wales (CT, ST, CWS, SWS, SWP), south-eastern, central to mainly western Victoria and eastern South Australia (FR, EA, NL, MU, SL, KI, SE).

Voucher specimens

SOUTH AUSTRALIA: *Flinders Ranges*: *A.S. Weston 1667* (AD); *Southern Lofty*: *H. Eichler 16299* (AD); *South-eastern*: *L.D. Williams 12418* (AD). VICTORIA: *East Gippsland*: *A.C. Beauglehole 33931* (MEL); *Eastern Highlands*: *A.C. Beauglehole 77886* (MEL). NEW SOUTH WALES: *North Western Plains*: *R.D. Hoogland 12295* (NSW; A, BRI, K, L, MEL, P n.v.)

Notes

H. incana has never received full recognition. There is no evidence that Bentham (1863) saw a type of it when he used the species as the basis for his *H. stricta* var. *canescens*. It would seem that he based his decision on two specimens from Balmy Creek, south-eastern Queensland (*T.L. Mitchell 524*, *579* - K), which do indeed belong in the *H. riparia* complex which includes *H. stricta*. *H. incana* belongs in the *H. sericea* complex because of its long axillary hairs and hairs between the petals and stamens. Bentham's placing of *H. incana* then explains why he identified some specimens of this species as *H. sericea* in a wider sense and published the combination in *Hibbertia*. The synonymy cannot be clearly assessed because it is usually difficult to evaluate which specimens were seen by various authors.

H. incana shares with *H. sericea* the presence of terminal clusters of flowers as well as the unusual character of tufts of hair between the stamens and the petals, a feature which distinguishes it from some similar forms of the *H. riparia* complex. The equally dense tomentum on both surfaces of the leaves and being composed of stellate hairs with usually a few scattered long simple hairs, the central ridge being continued to the apex of the cauline leaves, and the upper two-thirds of the outer sepals being covered on the inside with stellate hairs (cf. Fig. 1H–L) distinguish it from *H. sericea* var. *sericea* and var. *scabrifolia*, while var. *major* shares the latter two characters with it, but is mainly found on the Eyre and York Peninsulas where *H. incana* does not occur.

H. incana and *H. sericea* are very variable and the two species have usually been amalgamated as the variation of their characters seemed to overlap. For instance, in the northern Grampians a particularly hairy form is found resembling *H. incana* in that respect, but it must be identified as *H. sericea* because the central ridge of the cauline leaves does not extend up to their apex and also the outer sepals tend to be covered up to about half their inner surface with fine stellate hairs. The cauline leaves are also relatively broad-elliptic and the undersurface between the revolute margins and the central ridge is exposed unlike the usually tight linear or linear-triangular leaves of typical *H. incana*, which has also been recorded from parts of the Grampians (e.g. near Brim Springs, *H.R. Toelken 8367*). The possibility of hybridisation can therefore not be excluded. It will, however, be

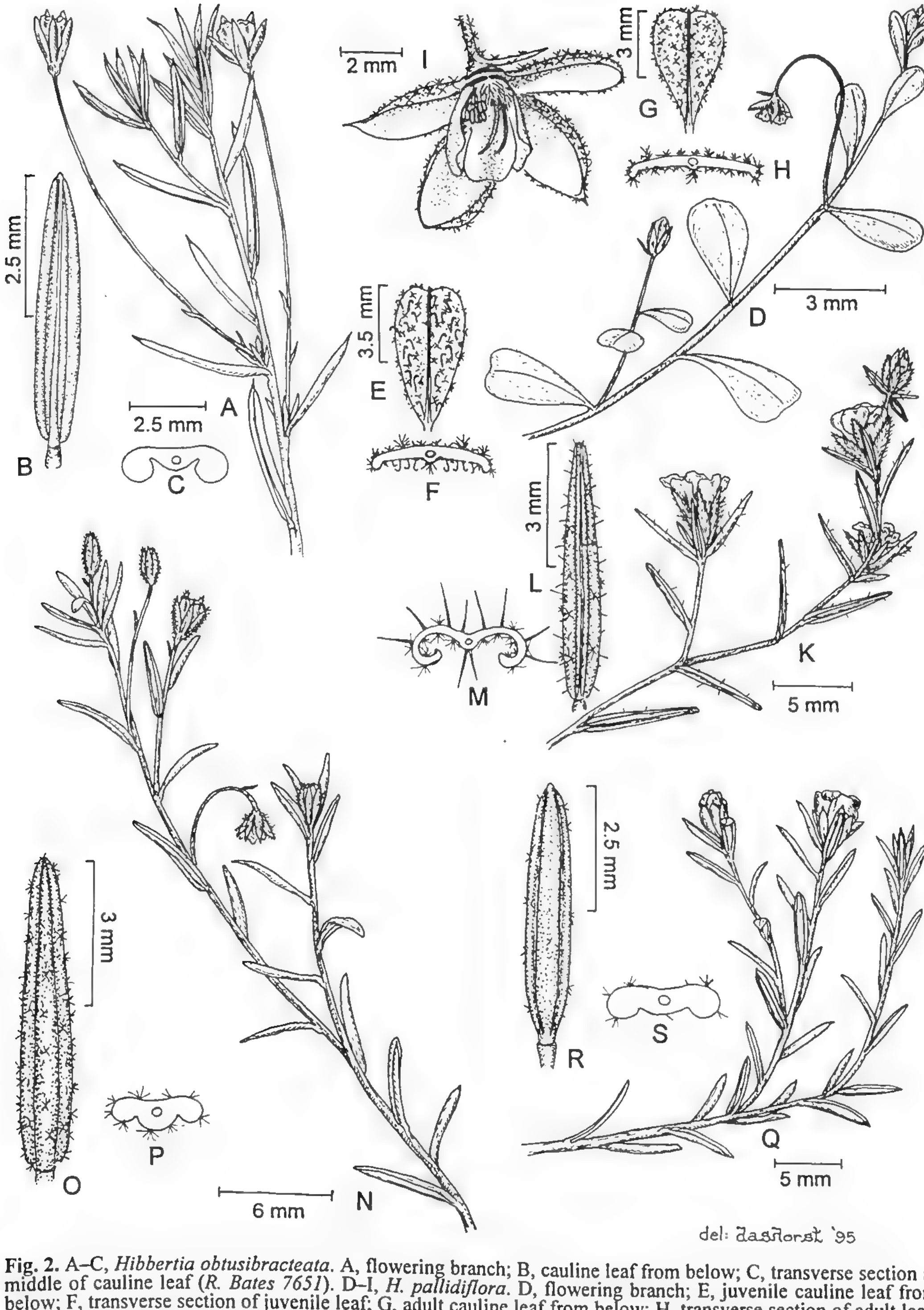

Fig. 2. A–C, *Hibbertia obtusibracteata*. A, flowering branch; B, cauline leaf from below; C, transverse section at middle of cauline leaf (*R. Bates 7651*). D–I, *H. pallidiflora*. D, flowering branch; E, juvenile cauline leaf from below; F, transverse section of juvenile leaf; G, adult cauline leaf from below; H, transverse section of adult leaf; I, flower with one sepal and two petals removed (D–H, *A.G. Spooner 10769*; I, *H.R. Toelken 8567*). K–M, *H. sessiliflora*. K, flowering branch; L, cauline leaf from below; M, transverse section at middle of cauline leaf (*H.R. Toelken 8358*). N–O, *H. tenuis*. N, flowering branch; O, cauline leaf from below; P, transverse section at middle of cauline leaf (*R.Bates 4051*). Q–S, *H. torulosa*. Q, flowering branch; R, cauline leaf from below; S, transverse section at middle of cauline leaf (*Clucas s.n.*, AD).

difficult to locate hybrid populations as much of the vegetation of the adjoining flats from where *H. incana* was mainly recorded has been disturbed. Hybrids have not been recorded from other localities where both species were found growing close to one another, e.g. Mary Seymour Conservation Park, *R. Bates 11689, 11690.* All indications are that these very hairy plants from parts of the Grampians are a form of the variable *H. sericea.*

Similar populations with larger cauline leaves with often exposed undersurface recorded from forested areas of the Mt Lofty Ranges must be identified as *H. incana.* Their cauline leaves are linear-triangular throughout, the central ridge extends visibly to the apex, and at least two-thirds of the inner surface of the outer sepals are covered with stellate hairs. Here a full range of intermediates has been recorded from large shrubs sometimes up to 2 m high and up to 2.5 m across to the commoner spreading shrubs usually less than 0.8× 1.5 m. The shape and size of the whole plant and its individual organs vary greatly with environmental conditions, or whether it is a young vigorously growing plant as compared with a senescent one.

In distribution the two species also show slight overlap but for most of their distribution they are quite separate. While *H. sericea* occurs along much of the coastal areas of Victoria and southern South Australia as well as Tasmania, *H. incana* has essentially an inland distribution. In New South Wales *H. incana* occurs from the Central Tablelands mainly north of the mountain ranges associated with the Australian Alps, which it skirts, into central and eastern Victoria, but has most commonly been recorded from western Victoria, and generally eastern South Australia.

Two forms, each of which occurs over a large area, can commonly be recognised within this species. The form including the type specimen may or may not have long simple hairs mainly along the margins of cauline leaves and they are generally absent from the central ridge and, in particular, its base. Since these long hairs wear off easily this character is not always available but the tufts of hairs in the axils of leaves are 0–0.6 mm long in this form and 0.5–1.2 mm or rarely up to 1.8 mm below the inflorescences in the more widespread form. Both of these characters become unworkable in specimens of depauperate and senescent plants, so that no infraspecific taxa can be clearly delineated although the provenance of most of the material is obvious.

The hairs of *H. incana* are much finer (0.01–0.015 mm diam.) than those of *H. sericea* (0.025–0.04 mm diam.) and the former would have better deserved the name 'silky' (=*sericea*), but the holotype of *H. sericea* (G!) confirmed the present interpretation.

H. obtusibracteata Toelken, *sp. nov.*

H. acicularis sensu Jessop in Jessop & Toelken, Fl. S. Austr. 4 edn, 1: 354 (1986), non (Labill.) F. Muell.

A *H. aciculari* plantis omnibus glabris, bracteis obtusis ad basim pedunculi elongati, stylis affixis dorsaliter versus medium; a *H. rufa* plantis omnibus glabris, habito rigido effuso filisque discretis differt.

Type: Kangaroo Island, Branch Creek Road, *R. Bates 7651*, 2.xi.1986 (holo.: AD; iso.: CANB, G, K, MEL, MO).

Much-branched shrublets with glabrous spreading to decumbent branches 15–40 cm long. *Tomentum* absent except for fine tubercles sometimes on leaf surfaces. *Leaves* without axillary tufts of hairs; *petiole* 0.1–0.3 mm long; *lamina* linear to linear-lanceolate, (2-) 2.8–4.4 (-5.6)× 0.4–0.6 (-0.75) mm, pointed with deciduous terminal bristle on usually slightly incurved protruding central ridge, abruptly constricted into short petiole, above more or less convex, below with raised revolute margins touching broad recessed central ridge. *Flowers* on peduncle (2.5-) 4.4–19.5 mm long, terminal mainly on short shoots sometimes only with

a few reduced leaves followed by an obtuse to rounded bract 0.6–1.6 mm long and on the lower third of the peduncle. *Sepals* 3.4–4.8 mm long, outer linear-elliptic, obtuse to rounded and more or less tinged red, inner oblong-ovate to oblong, rounded and usually pale green tinged red towards the apex, glabrous. *Petals* obovate, 4.2–6.6 mm long, bright yellow. *Stamens* (4-) 6 (-7) in one cluster; *filaments* free or almost so; *anthers* oblong with cuneate base. *Carpels* 2, glabrous, with styles from mid-dorsal side. *Seeds* elongate comma-shaped, with menbranous aril elongated downwards and a short sheath around the attachment of the seed. Fig. 2A–C.

Distribution and ecology

Growing on laterite or often on ironstone in scrub vegetation or mallee heath on Kangaroo Island.

Voucher specimens

SOUTH AUSTRALIA: *Kangaroo Island*: *G. Jackson 1498* (AD); *B.M. Overton 273* (AD).

Notes

H. obtusibracteata combines many characteristics of *H. acicularis* and *H. rufa*. Its more rigid habit of spreading much-branched stems with short internodes and spreading bristle-tipped leaves as well as free filaments resemble *H. acicularis*, but it differs by the shorter and softer leaves, the obtuse bracts together with two or three reduced leaves at the base of the usually red peduncle, and the mid-dorsal attachment of the styles to the ovary. The latter are all characters found in *H. rufa* which differs in addition to the above characters from *H. acicularis* by the presence of some hairs on at least young branches and leaves as well as in the axils of leaves, and typically the apex of young leaves are crowned by a tuft of short hairs or rarely almost papillae. The name is derived from the obtuse bracts found in this species.

Hibbertia pallidiflora Toelken, *sp. nov.*

A *H. aspera*, *H. cinerea* et *H. empetrifolia* floribus recurvis petalis tubularibus quam sepalis brevioribus, staminibus quam stylis rectis multo brevioribus et antheris appendiculatis differt.

Type: South Australia, southern York Peninsula, along Hillock Road, *H.R. Toelken 8567*, 2.x.1994 (holo.: AD; iso.: B, CANB, G, K, MEL, MO, NSW, NY, S).

Usually dense shrublets with flexible branches often scrambling to 1.5 m rarely up to 4 m high, pubescent to puberulous. *Tomentum* of tubercle-based mainly stellate hairs of different sizes with usually many branches, on branches, leaves and calyx, but juvenile leaves mainly with simple hooked hairs on the undersurface. *Leaves* without axillary tuft of hairs; *petiole* 0.2–0.9 (-1.6) mm long; *lamina* obovate to oblanceolate, (1.8-) 2.3–10.4 (-13.1)× 0.9–6.5 (-7.2) mm, rounded to rarely obtuse with apex of central vein bulging and covered with stellate hairs, more or less abruptly tapering into petiole, usually flat, above pubescent, rarely puberulous or tomentose, below pubescent to tomentose or on juvenile leaves puberulous with mainly simple hooked hairs between the recurved margins and central vein with mainly stellate hairs. *Flowers* on peduncle (0.8-) 2.2–9.5 (-17.3) mm long, terminal on all branches or leaf-opposing when overtopped by growth from axillary buds, with linear bract 1.2–2.2 mm long, subtending calyx. *Sepals* 2.1–3.9 mm long, outer ovate and acuminate, inner oblong-ovate and rounded or obtuse, pubescent, pale green. *Petals* oblong-obovate to almost orbicular, entire to more or less bilobed, 1.3–2.5 mm long, cream to pale yellow turning rusty-orange when dry. *Stamens* 8–13 in one cluster; *filaments* basally connate; *anthers* oblong, apiculate. *Carpels* 2, pubescent, with erect styles from the apex. Fig. 2D–I.

Distribution and ecology

Growing usually in moist sandy soils sometimes close to temporarily flooded areas or often associated with surface limestone in scrub vegetation close to the coast and associated with mallee, particularly *Eucalyptus diversifolia*; in South Australia recorded from the southern Yorke and Fleurieu Peninsulas, Kangaroo Island and scattered through mainly the coastal areas of the South-East. Its distribution has been poorly recorded, which in part at least may be attributed to its elusive flowers. It is protected in several conservation parks.

Voucher specimens

SOUTH AUSTRALIA: *Yorke Peninsula*: *A.G. Spooner 10769* (AD); *Southern Lofty*: *R. Bates 9487* (AD); *Kangaroo Island: P. Martensz 276* (AD, CANB, K, MEL, L); *South-eastern*: *P. Gibbons 600* (AD).

Notes

R. Bates first drew my attention to the tubular corolla which is usually not obvious in dried material. It is now clear from investigations in the field that this is part of a pollination syndrome unique in the genus. The small flowers are curved downwards so that the petals are not visible from above. The pale yellow petals open to form a cylindrical tube around the erect styles with the stigmas just below its opening, and the small stamens close to the ovary. The stigmas are therefore not situated below the apex of the anthers as in *H. aspera*, *H. cinerea* and *H. empetrifolia*.

The flexible branches scramble up shrubs or trees often up to 1.5 m high, but *Bates 7620* records them up to 4 m high in trees in Flinders Chase National Park, Kangaroo Island.

The tomentum of the leaves of this species is also unusual in that it is at first similar to that of *H. empetrifolia* with hooked hairs on the undersurface, but then develops in a short transition zone to mainly stellate hairs resulting in stellate-pubescent to -tomentose leaves similar to *H. aspera* and *H. cinerea*. In the western populations centred around Kangaroo Island the adult leaves with mainly stellate hairs predominate but in plants from the South-East they often never develop. At present it cannot be conclusively assessed whether the retention of this juvenile character results from the wetter environment as these plants have usually been recorded from next to marshes or temporarily inundated areas and only a few specimens (e.g. Younghusband Peninsula, *L.D. Williams 5445*; Lake Bonney, *J.B. Cleland AD 96227101*) do have adult leaves. Alternatively, this behaviour may be due to a slight local genetic variation, which is expressed in a wetter habitat but sometimes occurs together with some plants of the typical form of the species. The latter seem to apply since the specimen *Bates 16314* from 'mallee on limestone' - the common drier habitat in western populations of the species - in Mt Scott Conservation Park shows only juvenile leaves.

The epithet 'pallidiflora', pale-flowered in Latin, refers to the pale yellow petals.

Hibbertia sessiliflora Toelken, *sp. nov.*

H. stricta var. *readeri* Ewart in Ewart & Jean White, Proc. Roy. Soc. Victoria NS 21, 2: 543 (1909).

Type: Victoria, Casterton, *F.M. Reader s.n.*, 30.vii.1908 (lecto., selected here: MEL 35752; syn.: MEL 695563, NSW 101987).

A *H. sericea* subsp. *scabrifolia* foliorum laminis ellipticis basibus cuneatis et subtus vena centrale angustissima, ramis glabrescentibus filo metallico similis differt.

Type: Victoria, near Dergholm, *H.R. Toelken 8358* (holo.: AD; iso.: B, CANB, G, K, MEL, MO, NSW, NY).

Shrublets with erect to decumbent woody stems 0.1–0.5 m long and with spreading puberulous wiry branches with internodes up to 2.3 cm long and reddish-brown becoming greyish. *Tomentum* of tubercle-based stellate hairs under coarse simple hairs soon wearing off on branches and leaves but retained on calyx. *Leaves* with axillary tuft of hairs 1.3–1.7 mm long or about twice as long as petiole at least towards the apex of branches; *petiole* 0.2–0.6 mm long; *lamina* linear-elliptic to rarely -lanceolate or elliptic, (3.6-) 4.5–8 (-9.6)× (1.2-) 1.5–2.3 (-3.2) mm, gradually constricted into blunt apex with tuft of simple hairs and into short petiole, discolorous, above convex and with scattered stellate hairs under simple hairs soon glabrescent, below with narrow to broader recurved to revolute margins well raised above the narrow central vein and stellate-tomentose with scattered longer simple hairs mainly on the central vein. *Flowers* sessile, terminal on mainly short shoots often with only reduced leaves and 3 more densely hairy bracts 1.2–1.5 mm long or up to quarter of the calyx, or on long shoots with similar bracts and reduced leaves. *Sepals* 5.4–6.3 mm long, subequal, acute to pointed, outside densely covered with coarse simple hairs over finer stellate ones, inside glabrous except mainly simple hairs on upper third of outer sepals, reddish-brown to greyish-brown. *Petals* obovate, 3.8–9.6 mm long, mid to bright and deep yellow. *Stamens* 4–8 (-10) in one cluster; *filaments* free or basally connate; *anthers* oblong, usually tapering above and below. *Carpels* 2, woolly, with styles each attached to the dorsal apex. Fig. 2K–M.

Distribution and ecology

Growing on winter-wet clay flats under scrub vegetation between or rarely under *Eucalyptus* woodland. Restricted to few localities in western Victoria and adjoining South Australia; the conservation status is in urgent need of review.

Voucher specimens

SOUTH AUSTRALIA: *South-eastern*: *P. Gibbons 140* (AD, MO); *J.Z. Weber 7323* (AD, CANB). VICTORIA: *Wannon*: *F.M. Reader s.n.* (MEL, NSW).

Notes

This species resembles *H. sericea* var. *scabrifolia* in having relatively long coarse simple hairs in the leaf axils and on the sepals as well as usually several reduced leaves at the base of each flower, but should rather be placed close to *H. riparia*, because of its single terminal flower borne usually on short shoots and the absence of hairs between the stamens and the petals. The long coarse simple hairs in the leaf axils and on the calyx distinguish this species from other forms in the *H. riparia* complex. The decumbent habit of *H. sessiliflora* is also unusual although young plants often have erect branches each ending in a single flower.

H. stricta var. *readeri* has not been raised to species level as it was never taken up in literature and even Ewart (1931) himself did not refer to it in his Flora of Victoria. The most complete specimen, which also seems to have F.M. Reader's original label attached, was chosen as a lectotype, as it seems that the variety was described based on all the material, and duplicates with the name written on the label were later distributed. The epithet 'sessiliflora', sessile-flowered in Latin, refers to the many flowers along the stem which appear to be sessile as they are borne on very short short shoots.

H. tenuis Toelken & R. Bates, *sp. nov.*

A *H. riparia* sens. lat. differentiis collectivis distinctur: habitus debilis procumbens, folia breves (4–7 (-12) mm longa) costis centralibus quam marginibus revolutis petiolisque latioribus, pedunculi filiformes et fructus recurvi, 4–6 stamina.

Type: South Australia, near Yundi, *H.R. Toelken 8329*, 14.xii.1991 (holo.: AD; iso.: B, CANB, G, K, MEL, NY).

Shrublets with procumbent to scrambling, puberulous branches to 0.5 m long. *Tomentum* of fine tubercle-based mainly stellate hairs with usually many more or less equal branches spreading in all directions, on branches and calyx while with 1–3 branches on the upper surface of leaves. *Leaves* without axillary tuft of hairs; *petiole* 0.2–0.5 mm long; *lamina* linear, (3.6-) 4.4–7 (-12.2)× 0.7–1.1 (-1.5) mm, obtuse to rounded with abruptly constricted apex of central ridge recurved and scarcely protruding, abruptly constricted into petiole, above convex and puberulous with hairs with 1–3, usually forward-directed branches, below with central ridge much broader than revolute margins and puberulous with much-branched hairs. *Flowers* on filiform peduncle 4–18 mm long and recurved after flowering, terminal on long and short shoots but usually leaf-opposed due to sympodial growth, with linear or linear-lanceolate bracts 1.4–2.8 mm long, usually about one third down from calyx and without recurved margins. *Sepals* 4.1–5.3 mm long, outer narrowly lanceolate and acuminate, inner narrowly oblong and acute to rounded, puberulous with short much-branched stellate hairs, pale green. *Petals* obovate to oblong-obovate, 5.2–7.8 mm long, mid to bright yellow. *Stamens* 4–6 in one cluster; *filaments* free or almost so; *anthers* oblong, truncate. *Carpels* 2, puberulous, recurved with erect styles attached to the dorsal apex. Fig. 2N–P.

Distribution and ecology

Restricted to low or open vegetation in permanent wet places in the vicinity of Mt Compass where its conservation status is highly vulnerable.

Voucher specimens

SOUTH AUSTRALIA: *Southern Lofty*: *R. Bates 4051*, 10.xi.1977 (AD); *655*, -.4.1980 (AD).

Notes

A local endemic which superficially resembles *H. australis* N.A. Wakef., but is distinguished by its delicate procumbent habit, short leaves with sparse stellate hairs of 1–3 branches above, relatively broad central ridge and recurved fruiting peduncle. The specific epithet 'tenuis', delicate in Latin, refers to its more delicate and slender habit in comparison to *H. australis.*

H. tenuis, like most species of *Hibbertia* growing in permanent moist places, produces flowers the whole year round.

Hibbertia torulosa Toelken, *sp. nov.*

H. serpyllifoliae similis sed staminibus aggregatis praesentiaque pilorum stellatorum differt.

Type: Cultivated specimen, *E. Clucas s.n.*, 7.x.1994 (originally from near Bemm River in Victoria)(holo.: MEL; iso.: AD, K).

Shrublets with spreading pubescent knobby branches, up to 0.6 m high, much branched. *Tomentum* of fine tubercle-based hairs usually simple over stellate hairs with up to 4 branches, on branches and leaves as well as the apices of the sepals. *Leaves* with axillary tufts of hairs 0.3–0.6 mm long; *petiole* 0–0.25 mm long; *lamina* linear, 1.9–4.3 (-6.2)× 0.7–1.2 mm, abruptly tapering into blunt apex with tuft of hairs on protruding central ridge, scarcely constricted into short petiole, above convex and puberulous, below with broad revolute margins touching slightly recessed broader central ridge and puberulous, straight, erect. *Flowers* subsessile, terminal on all branches but mainly on short shoots, with linear-

triangular bract 0.8–1.3 mm long and without recurved margins. *Sepals* (3.8-) 4.3–5.4 mm long, outer lanceolate and acuminate or acute, inner ovate and acute to obtuse, pubescent towards the apex, yellowish-green. *Petals* obovate, 4.8–6.2 (-7.6) mm long, mid to bright yellow. *Stamens* 6 in one cluster; *filaments* free; *anthers* oblong, truncate above and below. *Carpels* 2, villose to tomentose, with erect styles from dorsal apex. Fig. 2Q–S.

Distribution and ecology

The species is known only from the type collection from woodland near Bemm River so that it seems to represent a vulnerable very local taxon.

Notes

H. torulosa is superficially similar to *H. serpyllifolia* and distinguished not only by stamens grouped in one cluster but mainly because this is part of a different pollination syndrome. While the three styles of *H. serpyllifolia* spread laterally away from the erect stamens arranged around the ovary, the two styles of *H. torulosa* curve upwards so that their stigmas are situated above the group of stamens. The latter type of flowers and the presence of distinct stellate hairs especially on the branches indicate a closer relation to some forms of the *H. riparia* complex from Tasmania.

Since the description is based on cultivated material the measurements of various organs might be somewhat larger than in plants collected in the field. The type specimen prepared in spring does not differ significantly from an earlier specimen received in autumn. However, it has straighter branches with less pronounced leaf bases so that the branchlets appear less knobby, *torulosa* in Latin.

Acknowledgements

I am indebted to Bob Bates, who with his keen eye for the unusual has brought many a special form of *Hibbertia* to my attention and thus greatly helped me to cover the large field of variation in this genus. Mr E. Clucas sent me specimens of *H. torulosa*, which he had collected and cultivated at his Kuranga Native Plant Nursery. Numerous communications from Mr R. Thomas and the many specimens of *H. humifusa* especially from the various populations he located near Euroa greatly helped in evaluating that complex.

A grant from the Research Fund of the Botanic Gardens of Adelaide is gratefully acknowledged, as it enabled the author to examine specimens relevant to this paper in de Candolle's herbarium in Geneva. Field work on some of the above complexes has been made possible by a grant from ABRS. I would also like to acknowledge the loan of a great number of *Hibbertia* specimens from CANB, CBG, BRI, HO, MEL and NSW.

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J. Adelaide Bot. Gard. 16: 73–78 (1995)

A NEW SERIES, *INCOGNITAE*, OF *EUCALYPTUS* L'HÉR., INCLUDING A NEW SPECIES ENDEMIC TO FLEURIEU PENINSULA AND KANGAROO ISLAND, SOUTH AUSTRALIA

D. Nicolle

Abstract

A new series, *Incognitae,* is described. It comprises *Eucalyptus longifolia, E. cosmophylla* and a newly described species, *E. paludicola* D. Nicolle, a small tree of restricted distribution on central and southern Fleurieu Peninsula and south western Kangaroo Island. A key is provided for the three species of ser. *Ingognitae.*

Introduction

Eucalyptus paludicola was first brought to my attention by M.I.H. Brooker of the Australian National Herbarium from a herbarium specimen (*A.G. Spooner 5206*) seen in CANB under the name *E. ovata*. The population from which this and most other specimens currently in herbaria were taken occurs in Cox's Scrub Conservation Park. Following further field surveys, more populations were found. It became apparent that this was a new and distinct taxon. It is easily distinguished from *E. cosmophylla* in the field by its erect tree habit, predominantly seven-flowered inflorescences, and occurrence in swampy habitat. A new series is erected to accommodate this new species and two other species previously included in ser. *Lepidotae – Fimbriatae* Maiden.

Eucalyptus ser. Incognitae D. Nicolle, *ser. nov.*

Arbores vel frutices "mallees". *Cortex* fibrosa, brunnea vel cinerea, per laevis granularis, cremea vel cinerea. *Cotyledones* bilobae. *Folia juvenilia* petiolata, remanentia opposita per nodis paucis, turn alternantia, late lanceolata ad orbicularia, hebetia, discoloria. *Folia adulta* hebetia vel nitentia, concoloria, reticulo moderato vel denso, glandulis paucis. *Inflorescentiae* axillares, 3 vel 7 floribus. *Filamenta* staminum inflexa, anthera versatiles, dehiscentes rimis longitudinalibus. *Fructus* obconici, cylindrici vel cupulares, valvis inclusis ad rimum. *Ovula* verticaliter 4 vel 8-seriata. *Semina* nigra, nitentia, aliquantum pyramidalia.

Typus: *Eucalyptus cosmophylla* F. Muell.

Small to tall *trees* or *mallees. Bark* brown to grey, rough over part or all of the stems or smooth, granular, cream to grey bark. *Cotyledons* bilobed. *Juvenile leaves* petiolate, opposite, becoming alternate by the sixth pair, dull, strongly discolorous, broad-lanceolate to orbicular. *Adult leaves* dull to glossy, concolorous, *reticulation* moderate to dense, oil glands sparse. *Inflorescences* axillary, 3 or 7 flowered. Staminal filaments inflexed, anthers versatile, opening by longitudinal slits. *Mature fruit* cylindrical to cupular or somewhat obconical, valves to rim-level. *Ovules* in 4–8 vertical rows. *Seed* black, glossy, somewhat pyramidal.

Etymology

The epithet is derived from Latin *incognitus* (with identity concealed), referring to the fact that until now the series was included with the cognate *E.* ser. *Lepidotae – Fimbriatae* (grey gums).

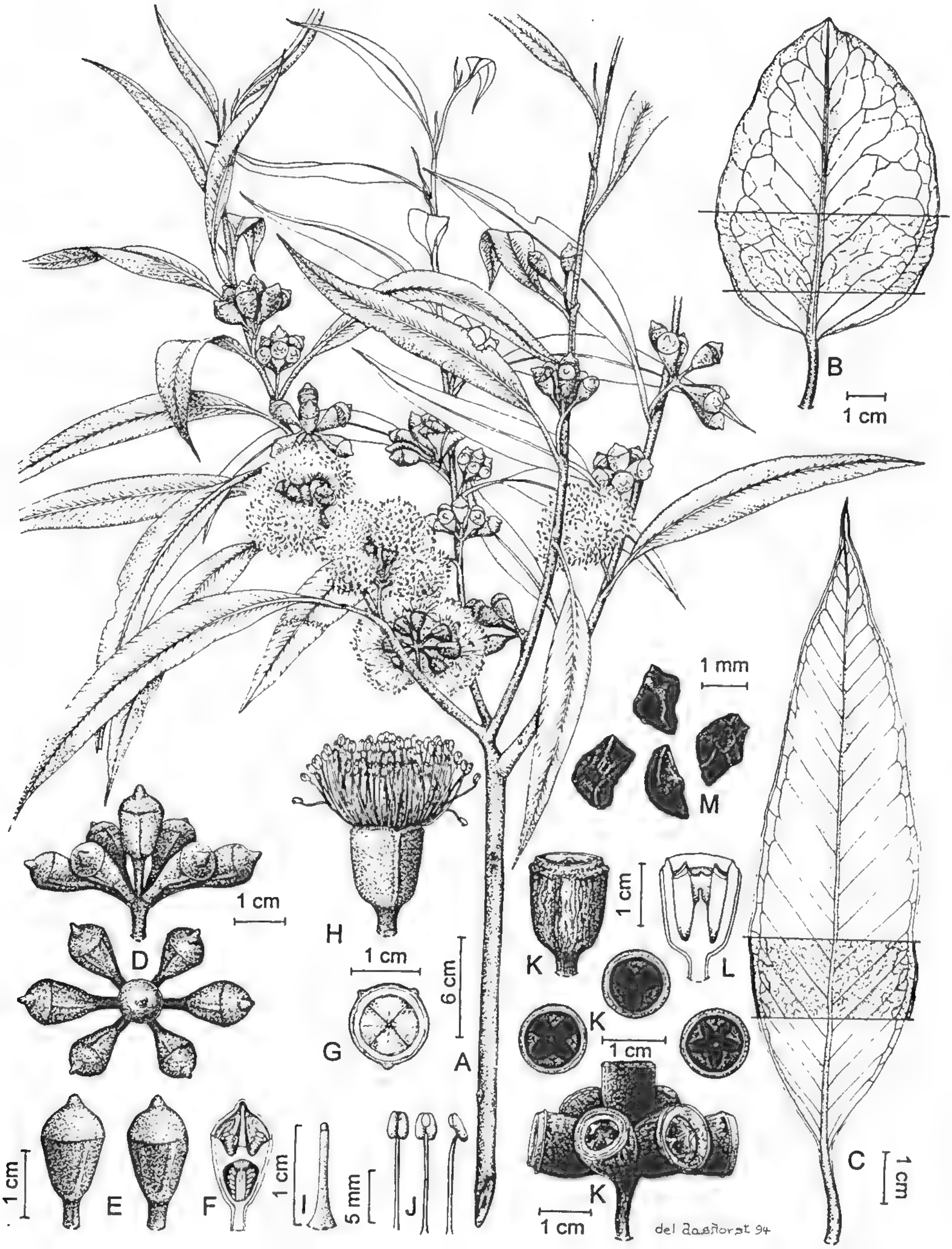


Fig. 1. *E. paludicola* (*D. Nicolle 95*). A, flowering branch; B, juvenile leaf (*D. Nicolle 99*); C, adult leaf; D, inflorescences; E, buds in side view; F, bud in longitudinal section; G, flower with stamens removed as seen from above; H, flower; I, style; J, stamens; K, fruits; L, fruit in longitudinal section; M, seeds.

Notes

Series *Incognitae* differs from series *Lepidotae – Fimbriatae* Maiden in which it was previously included by the less colourful, smooth bark (often shades of coppery and orange in ser. *Lepidotae – Fimbriatae*), broad-lanceolate to orbicular juvenile leaves (narrow lanceolate to lanceolate in ser. *Lepidotae – Fimbriatae),* concolorous adult leaves (strongly discolorous in ser. *Lepidotae – Fimbriatae*), sparsely distributed oil glands in adult leaves (more numerous in ser. *Lepidotae – Fimbriatae*), valves only to rim level (exserted in ser. *Lepidotae – Fimbriatae*) and consistently black seed (brown or black seed in ser. *Lepidotae – Fimbriatae*).

The *E.* series *Incognitae* occurs in South Australia and New South Wales, possibly extending into Victoria while the *Lepidotae – Fimbriatae* are restricted to Queensland and New South Wales.

Eucalyptus paludicola D. Nicolle, *sp. nov.*

Arbor parva ad 10 m alta. *Eucalypto cosmophyllae* F. Muell. affinis, a qua habitu arboreo, cortice persistenti fibroso ad basin (ad 3m). Umbellastrae 7–florae, alabastris fructibusque parvis, cylindricis vel obconicis, pedunculis longis, habitatione paludosa differt.

Typus: 7.5 km from Mount Compass towards Nangkita opposite "Sunnyside" 35°22'S, 138°40'E, *D. Nicolle 95*, 10.x.1992 (holo.: AD; iso.: CANB).

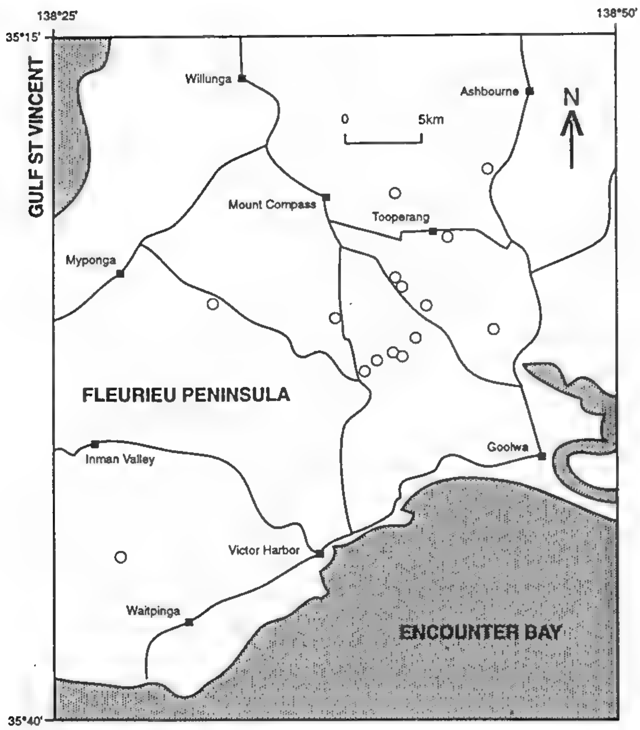
Small tree 4–10 m tall, trunk usually erect, sometimes multi-stemmed. *Bark* dark brown, rough, thick and coarsely fibrous on the trunk up to 3 m high then smooth grey over light grey and cream. *Cotyledons* bilobed; *juvenile leaves* petiolate, opposite, becoming alternate by sixth pair, elliptical to orbicular, up to 100 × 70 mm, discolorous, dull, dark green above, paler green below. *Adult leaves* alternate, broad-lanceolate to lanceolate, sometimes falcate, up to 210 × 40 mm, dull at first, becoming slightly glossy, concolorous, dark green to bluish green. *Reticulation* dense with sparse, intersectional oil glands. *Inflorescences* axillary, unbranched, predominantly (3) 7-flowered, peduncles angular to slightly flattened, 7–15 mm long, pedicels to 5 mm long. *Mature buds* creamy white in colour, hypanthium obconical. *Operculum* same width as hypanthium, shortly conical to hemispherical, apiculate. *Stamens* inflexed, all fertile; filaments creamy white. *Ovules* in (4) 6 (8) rows. *Mature fruit* subsessile to pedicellate, cylindrical to obconical or slightly campanulate, smooth, up to 14 × 12 mm. *Operculum scar* vertically ascending, conspicuous, 0.5–2 mm wide, disc level to descending, valves (3) 4 (5), to rim level. *Seed* black, somewhat pyramidal. Figs 1–3.

Etymology

The epithet is derived from the Latin *paludis* (marsh) and *cola* (dweller) and refers to its common habitat in swampy and seasonally inundated low lying areas.

Selected specimens

SOUTH AUSTRALIA. SOUTHERN LOFTY (north to south): 200 m in from main road on south edge of Cox's Scrub, 35°21'S, 138°44'E, *D. Nicolle 69*, 20.vi.1992 (AD, CANB); south side of Cox's Scrub, 200 m north west of Bonds Road in creek, 35°21'S, 138°44'E, *D. Nicolle 94*, 10.x.1992 (AD); Cox's Scrub, south Mount Lofty Ranges, 35°21'S, 138°44'E, *B.C. Crisp 57*, 13.xii.1970 (AD); Cox's Scrub Conservation Park, 35°21'S, 138°44'E, *A.G. Spooner 5206*, 21.v.1977 (AD); on north slope of Bottom Creek Farm, Tooperang, 35°23'S, 138°41'E, *C.M. Eardley*, 8.ix.1946 (AD); 300 m from Mount Compass to Goolwa Road on Kokoda Road then 200 m east of road in valley, 35°25'S, 138°43'E, *D. Nicolle 101*, 31.x.1992 (AD); 400 m from Mount Compass to Victor Harbor Road on Mosquito Hill Road, 35°27'S, 138°38'E, *D. Nicolle 98*, 17.x.1992 (AD); valley north of Fraser Road and Victor Harbor to Cape Jervis Road intersection, 35°35'S, 138°28'E, *D. Nicolle 349 & M.I.H. Brooker*, 28.xii.1992 (AD, CANB).



Map 1. Distribution of *Eucalyptus paludicola* (O) on Fleurieu Peninsula

Distribution and habitat

E. paludicola occurs from near Waitpinga on southern Fleurieu Peninsula, north to east of Myponga and east towards Currency Creek and Ashbourne over a linear range of about 50 km. It is common in the area south of Tooperang and co-dominates some creek lines with *E. ovata*. *E. paludicola* always occurs in small, usually pure stands of between 10 and 100 plants surrounded by heath or low forest vegetation. The stands occur in low depress-ions, broad gullies or occas-ionally on hillsides near permanent creeks. The soils are sands and loams often with a high percentage of organic matter in the soil, but are waterlogged in winter with some populations having water up to 30 cm deep around the stems for three months in the 1992 winter. *E. paludicola* grows only on the eastern and southern side of the Mount Lofty Ranges watershed where streams flow easterly or southerly into the Murray River Lakes or Southern Ocean, not westerly to the Gulf St. Vincent where *E. camaldulensis* is the dominant tree of the creeks and low-lying areas. Associated species include *E. baxteri*, *E. cosmophylla*, *E. fasciculosa*, *E. leucoxylon* ssp. *leucoxylon*, *E. odorata* and *E. ovata*. *E. paludicola* is the only tree species present on some sites. More recently it has been discovered at one site in Kelly Hill Conservation Park on Kangaroo Island where it is associated with *E. cosmophylla* and *E. leucoxylon*. Map 1.

Flowering period: September to November.

Notes and affinities

E. paludicola is distinguished from *E. cosmophylla* in the field by its predominantly seven-flowered inflorescences (three-flowered in *E. cosmophylla*), erect tree habit, longer pedicels and peduncles, more cylindrical smaller buds and fruits without prominent ridges (cup-shaped fruit with two opposite ridges in *E. cosmophylla*), thinner adult and juvenile leaves, thick rough bark on mature trees and swampy habitat. In the past, herbarium specimens of *E. paludicola* have been identified as unusual forms of *E. ovata* vars. *ovata* or *grandiflora*, presumably because of its swampy habitat and tree form, or *E. cosmophylla* to which it is more similar morphologically. The new species is intermediate in some respects between *E. cosmophylla* and *E. ovata*, such as habitat and seed characteristics. However, recent hybridism is considered unlikely as all populations show only minor variation in the seedlings and mature material, and *E. ovata* and *E. cosmophylla* co-occur at only a few of the known populations of *E. paludicola*. There are no sightings or collections of any

Fig. 2. Habit of *E. paludicola* (*D. Nicolle 101*).

intergrades or hybridism between *E. paludicola* and any other taxon. *E. paludicola* flowers prolifically and is conspicuous when in flower. It has potential as an ornamental tree and for reclaiming poorly drained areas where few other eucalyptus will survive.

Conservation status

E. paludicola is known from about 15 populations over a range of about 50 km. Most populations occur in roadside vegetation or private farmland and are in danger of accidental destruction or damage from road works. One population occurs on the boundary of Cox's Scrub Conservation Park (mostly within the reserve), and one population just outside the boundary of Scott Conservation Reserve. The Cox's Scrub population suffered from bush fire in 1983. The trees recovered by the epicormic shoots on the lower half of the stem. Some seedlings of *E. paludicola* also grew as a result of the fire and are now reproductively mature. The entire Kangaroo Island population is conserved in a remote part of Kelly Hill Conservation Park. The status code 3vci is suggested, using criteria of Briggs & Leigh (1988).

Key to Taxa in series *Incognitae*

1. Buds and fruit pendulous .... *E. longifolia*
1 Buds and fruit erect.
   2. Inflorescence predominantly three-flowered .... *E. cosmophylla*
   2 Inflorescence predominantly seven-flowered .... *E. paludicola*

Fig. 3. Bark on lower trunk (*D. Nicolle 101*).

Acknowledgements

I would like to thank Ian Brooker for bringing this species to my attention and checking the manuscript, Kevin Rule for helpful advice on the manuscript and John Jessop for advice on the manuscript and access to the State Herbarium. I am also grateful to Gilbert Dashorst for the detailed illustrations.

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PUBLICATION DATE OF 'FLORA OF SOUTH AUSTRALIA, PART III'

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Abstract

Although the publication date of the first edition of part III of J.M. Black's 'Flora of South Australia' is not known, it is here established that it must have been published prior to 15 December 1926. Since this predates the publication of the names of five species described in volume 50 of the 'Transactions and Proceedings of the Royal Society of South Australia', which was published on the 23rd December 1926, the protologues of these names are here regarded as being published in part III of the 'Flora of South Australia'. Lectotypes for *Logania insularis* J. Black and *L. recurva* J. Black are here chosen.

Introduction

While preparing a systematic revision of *Logania* section *Logania* (Loganiaceae) (Conn, in preparation), it was noted that the protologues of the names of *Logania recurva* J. Black and *L. insularis* J. Black were regarded by Robertson (in Black 1965) and Perry (in Jessop & Toelken 1986) as being published in volume 50 of the 'Transactions and Proceedings of the Royal Society of South Australia'. Since the publication date of this latter volume was the 23rd December 1926 (cited on title page of this volume), it was thought that it was likely that the third part of the 'Flora of South Australia' may have been published prior to this date.

Discussion

It is known that J.M. Black's scientific paper, 'Additions to the Flora of South Australia' was read to the Royal Society of South Australia on 'October 14, 1926' (Black 1926b, p. 283), and that it was published on 'December 23, 1926' ('Transactions and Proceedings of the Royal Society of South Australia', volume 50, title page). Although descriptions of some of these new species were included in Part III of the 'Flora of South Australia', the actual publication date of this latter part is only known to have been in December 1926 (Black 1929, endpaper). Attempts to establish the actual publication date of this part of the 'Flora' were unsuccessful even though the records of several organisations and institutions were investigated. Unfortunately, the printers of the 'Flora of South Australia' (namely, the State Printers of South Australia), have not retained publication records for this period (P. Moore, 12 July 1994, pers. comm.). Other records investigated included those of the Handbooks Committee of the 'Handbook of the Flora & Fauna of South Australia' series and those of several libraries.

The copy of Part III of the 'Flora of South Australia' held at the State Library of South Australia has an accession date or date of receipt of '1 December 1926' stamped on the cover (P. Moore, 12 July 1994, pers. comm.; photocopy seen). Since it is possible that the date of the stamp was not correctly set at the time the part was stamped, supporting evidence was sought. Unfortunately, the State Library of South Australia does not hold accession records for this period.

Evidence to support the suggestion that Part III of the 'Flora' predates Black (1926b) also comes from the copy of this part held at the Mitchell Library (Sydney, New South Wales). This part has the following handwritten annotation: 'Preece 2/- 15-12-26' (Black 1926a, on *verso*). The annotation refers to (i) 'Preece' (the Supplier); (ii) '2/-' (the cost – 2 shillings); and (iii) '15-12-26' (the date of receipt or accession – 15 December 1926). Therefore, this part must have been published prior to the 15th of December 1926 for it to have been received by the Mitchell Library by this date. Unfortunately, no other supporting evidence could be obtained. The records of the following libraries did not provide any information: the Barr Smith Library (University of Adelaide); the library of the National Herbarium of Victoria (MEL); the library of the National Herbarium of New South Wales (NSW); the library of the State Herbarium of South Australia; the CSIRO Black Mountain library (A.C.T.); and the CSIRO Division of Forestry library, Yarralumla (A.C.T.). The copies of the 'Flora' held by these latter institutions were either purchased as complete bound sets, after Part IV was published, or the individual parts were donated at a latter date. However, none of these copies had any information on the publication date, date of receipt or accession date.

Black (1926b) published the names of nine new species, of which five were described in Part III of the 'Flora' (Black 1926a). Since the publication date of Part III clearly predates the 'Transactions and Proceedings of the Royal Society of South Australia', the publication details of the protologues of these latter five species must be changed. The corrected publication details are given below.

Loganiaceae

1. **Logania recurva** J. Black, Fl. S. Austral. 456 ([pre 15] xii.1926); Trans. & Proc. Roy. Soc. S. Austral. 50: 283 (23.xii.1926).

Lectotype (here chosen): South Australia: 'Towards Scott's Creek, Mt Lofty' [Range], Herb. *J.M. Black s.n.* 16.x.1904 (male) (AD 97422217 – central specimen).

Other *syntypes*: South Australia: 'Ashton', Herb. *J.M. Black s.n.*, 7.ix.1905 (male) (AD 97422217 – lower right specimen); Bridgewater [Mt Lofty Range], Herb. *J.M. Black s.n.*, s.dat. (fr) (AD 97422216 – left specimen); Ardrossan [Yorke Peninsula], *Tepper s.n.*, s.dat. (male) (AD 97422216 – specimen second from right) (see Typification below).

Typification

The lectotype is a male flowering specimens. However, since both flowers and fruits are described in the protologue, it is here assumed that the fruiting specimen on AD 97422216 (namely, the left specimen) must have been used in the preparation of the description of this species. The origin of the third collection on AD 97422217 (centre left) is not known. Therefore, this specimen is not regarded as type material. Note: the other collections on AD 97422216 are all *Logania linifolia* Schldl.

2. **Logania insularis** J. Black, Fl. S. Austral. 457 ([pre 15] xii.1926); Trans. & Proc. Roy. Soc. S. Austral. 50: 285 (23.xii.1926).

Lectotype (here chosen): South Australia: 'Cape Borda, K.I.' [Kangaroo Island], *Griffiths s.n.*, -.x.1908 (male) (AD 97422218 – upper centre specimen); isolecto.: (AD 97422218 – upper right specimen); isolecto.: (MEL 501228).

Other *syntypes*: Cape Borda, Kangaroo Island, *Cleland s.n.*, 5.iii.1926 (male) (AD 97422218 – centre left specimen; MEL 501229); (fr) (AD 97422218 – lower left) (refer Typification below).

Typification

The syntype material of the name of this species, as held at the State Herbarium of South Australia (AD) and at the National Herbarium of Victoria (MEL), are mixed collections. The AD sheet has two male flowering specimens collected by *H.H.D. Griffith* (AD 97422218 – upper centre here chosen as the lectotype; upper right as isolectotype) and three collections by *J.B. Cleland* (two fruiting specimens and one male flowering specimen). The accompanying notes and illustrations, on this AD sheet, indicate that one of the fruiting *Cleland* specimens was collected on the '5/3/36' (presumably in Black's hand). Therefore, this specimen can not be regarded as type material because it was collected after the publication of the protologue. Unfortunately, the *Cleland* specimens on the AD sheet are not clearly labelled. The 1936 *Cleland* material was collected from a fruiting plant, which had some fertilised female flowers (corolla fallen off) (see Black's accompanying illustration on AD 97422218). The lower left and lower centre specimens are both fruiting, with the lower left specimen labelled '5/3/26 (J.B. Cleland)' (presumably in Black's hand). The other fruiting specimen is not annotated, but it may represent the 1936 collection. The centre left (*Cleland*) specimen, on AD 97422218, is a male flowering specimen. This specimen and the lower left specimen are regarded as other syntypes.

The syntype material held at MEL, consists of two sheets (namely, MEL 501228 & 501229). This material was previously part of a mixed unmounted collection in which it was not possible to identify the collector of each specimen (refer typed annotations on sheets). However, the material has been compared to the AD material and it is here concluded that the label information on each sheet has been assigned to the correct specimens. The *Griffith* collection has leaves which have dried a darker colour than those of the *Cleland* material (which have dried light green). Furthermore, the former has leaves which are larger and flatter than those of the *Cleland* specimens (which are strongly recurved). The specimen labelled as collected by *Griffith* (MEL 501228) is here chosen as an isolectotype. Since the *Griffith* and *Cleland* collections, as held at MEL, are both male flowering specimens, Black must have described the capsules from the *Cleland* syntype material held at AD (see above).

Convolvulaceae

3. **Ipomoea lonchophylla** J. Black, Fl. S. Austral. 466 ([pre 15] xii.1926); Trans. & Proc. Roy. Soc. S. Austral. 50: 285 & 286 (23.xii.1926).

Type: 'Minnie Downs', *'L. Reese'* s.n., s.dat., 'Oodnadatta', '*Miss Staer*', -.i.1913; 'Lake Harry near Hergott', *sine leg.*, s.dat.; 'Swallow Creek + Adminga Cr', 'Horn Exp.' [Expedition], s.dat. [11.v.1894? (R.W. Johnson, pers. comm. 18.viii.1994) (AD 97621512) (see Notes below).

Notes

Lectotypification is required for the name of this species. The protologue provides the following general description of the distribution of material considered by Black: 'Far North, from Marree and the Alberga to the country between Cooper's Creek and the Queensland border. – Central Australia' (Black 1926a, p. 466). R.W. Johnson (pers. comm. 18.viii.1994) suggests that the *Staer* collection from Oodnadatta may be a suitable lectotype for the name of this species.

The reference to the '*Trans. & Proc. Roy. Soc. W. Austral.*' by Chapman (1991, p. 1666) is a typographical error which should be corrected to the *Trans. & Proc. Roy. Soc. S. Austral.*

Solanaceae

4. **Nicotiana excelsior** (J. Black)J. Black, Fl. S. Austral. 502 ([pre 15] xii.1926); Trans. & Proc. Roy. Soc. S. Austral. 50: 286 (23.xii.1926).

Lectotype (*Horton 1981*): Mt Carminia [Carmeena], *S.A. White s.n.*, 12.viii.1914 (AD 97807202); isolecto.: NSW 141364.

Basionym: *Nicotiana suaveolens* Lehm. var. *excelsior* J. Black, Trans. & Proc. Roy. Soc. S. Austral. 39: 835, pl. 63 fig. 2, pl. 70 (1915).

Scrophulariaceae

5. **Veronica parnkalliana** J. Black, Fl. S. Austral. 512 ([pre 15] xii.1926); Trans. & Proc. Roy. Soc. S. Austral. 50: 286 (23.xii.1926).

Holotype (as annotated by F. Ehrendorfer, *anno* 1966): 'Port Lincoln' ('Near Pt. Lincoln' – Black 1926a, p. 512), '*H.H.D.G.*' [*H.H.D. Griffiths s.n.*], 10.x.1909 (AD 96645025).

Acknowledgements

I wish to thank all the librarians and staff of the following libraries: State Library of South Australia (Ms Patricia Moore); Mitchell Library (Mr David Pollock); the Barr Smith Library (University of Adelaide); the library of the National Herbarium of Victoria (MEL) (Ms Helen Cohn); the library of the National Herbarium of New South Wales (NSW) (Ms Anna Hallett); the CSIRO Black Mountain library (A.C.T.); and the CSIRO Division of Forestry library, Yarralumla (A.C.T.). These people promptly and thoroughly checked the records of their institutions. Dr John Jessop (AD) kindly contacted the Handbooks Committee (Handbook of the Flora & Fauna of South Australia Series) and allowed me access to the records of the library of the State Herbarium of South Australia (AD). Mr Bob Johnson (BRI) and Dr Hellmut Toelken (AD) kindly provided information on the type of *Ipomoea lonchophylla* J. Black. Dr Don Foreman (MEL) provided additional information about the syntypes of *Logania insularis* J. Black as held at his institution.

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J. Adelaide Bot. Gard. 16: 83–93 (1995)

RAINFALL HARVESTING TO ESTABLISH TREES AND SHRUBS ON FLAT, SANDY SOIL IN THE ARID ZONE

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Abstract

Seven surface materials on man-made rainfall catchments for single trees were evaluated as to their effect on collecting rainfall run-off to aid tree and shrub establishment on flat sandy soils in arid zones. The aim being to develop a catchment system that can substitute entirely for supplementary watering in arid zones.

Large variability in run-off occurred. After nine months residual herbicides were ineffective and weed germination broke up the surface materials and reduced run-off. Dry soil at the time of application of the surface materials also may have reduced their effectiveness. However, catchments sealed with cut-back bitumen tended to give more run-off than those sealed with a cement render or silicon products (silicone emulsion plus polymer latex, and sodium methyl siliconate). The 1.2 l/m² rate of cut-back bitumen tended to be giving more run-off than the 0.6 l/m² rate.

A catchment size of 4 m² treated with 1.2 l/m² of cut-back bitumen potentially substituted for three hand waterings, representing nett cost savings. Also, with this treatment, 2 mm of rain was sufficient to give a benefit to plants in the first year of its application, by shedding 3–4 l of run-off, providing it falls close to a few other small events or one larger one.

The practicality of applying the different surface treatments and the future directions are discussed.

Introduction

Making water available to plants is one of the most costly exercises of tree planting in the arid zone. If trees and shrubs are to be established in areas where piped water is not available, then water has to be carted to the trees. The contract cost of such watering was estimated to be 50¢ per plant per watering in 1985 (Kealley 1987). Various watering formulas are practised in the arid zone. Sandell *et al.* (1986) followed a program that meant up to 14 waterings in the first six months, but Kealley (1987) only used 8 waterings in the first year. Therefore, allowing for inflation, the minimum watering cost would be $6.56 per plant per year (1993 dollars), but in most situations it is likely to be far more than this.

Water can be made available to plants by watering, mulching, weed removal, fallowing and rainfall harvesting.

Dalton (1992) proposed that the most economical means of supplying seedlings with water is likely to be a combination of weed control with waterings during extended dry periods. This was tested using the following formula: water with 40 litres every 28 days, but if 25 mm or more rain occurs within a two day period, then defer the watering until 28 days after this rain. Plants did not do well when watering was reduced below this level (Dalton, unpublished data). Long term rainfall records from Port Augusta indicate that this formula would require an average of 8 waterings per plant per year (Bureau of Meteorology, Adelaide).

[1] We acknowledge the assistance of Tony Johnson, Parks Superintendent, City of Port Augusta and the funding provided by ETSA and the City of Port Augusta to enable the realisation of this trial.

Mulching is of known benefit in conserving moisture in heavy textured soils (Handreck & Black 1984), but is of little benefit on sandy soils, which are often 'self-mulching'. Organic mulch was of negligible benefit on a sandy soil at the Australian Arid Lands Botanic Park (AALBP) in a seedling planting trail in 1986 (Dalton 1992). Vermiculite plus paint or bitumen improved emergence of salt bushes (Malcolm & Swaan 1985), but the benefit is only for emergence and not long term growth.

Thus, the effects of watering, weed control and mulching on seedling survival and growth in arid zones is largely understood. Fallowing and rainfall harvesting have not been evaluated.

From the aspect of water storage, there is little to be gained from fallowing deep sands (French *et al.* 1968). Rainfall harvesting to concentrate water run-off at the seedling is used extensively in Israel, even in areas with as little rainfall as 80 mm per annum (Wilson 1980), but mainly on sites that are sloping and have a high run-off factor (either naturally or induced). Sandy and relatively flat sites would have to be formed into sloping catchments and possibly sealed to induce run-off and prevent erosion.

The aim of this work was to evaluate man-made single tree rainfall catchments for plant establishment on a flat, sandy, arid site, in order to try and establish seedlings without watering. With such large areas of the world being arid and sandy, such techniques have a potentially large scope and cost savings.

Materials and methods

(i) *Trial site*

The site was at the AALBP, Port Augusta, South Australia; latitude 32°32'24"; longitude 137°46'50"; altitude 4.34 m; average maximum temperature 32°C; average minimum temperature 7.3°C; mean annual rainfall 257 mm; mean relative humidity (3 p.m.) 38.6%; mean annual pan evaporation 2500 mm.

The soil is a mainly structureless, apedal, red clayey sand of two metres deep. The existing vegetation consists of *Maireana sedifolia, Sclerolaena obliquicuspis, Atriplex holocarpa, Sida intricata, Carrichtera annua, Enneapogon avenaceus*, and a *Stipa* sp.

(ii) *Catchment surface materials*

Methods and compounds with which soil surfaces have been sealed to improve water run-off include non-permeable bitumen (Laing 1981), paraffin waxes (Frasier *et al.* 1979), sodium salts (which break down structure of heavy soils) and plastic sheets (Wilson 1980) and silicone compounds (Plueddemann 1975). Also, Hudson (1987) reviews the work of others who have used crude oil, compaction, compaction with added clay, and concrete.

For tree seedling establishment a catchment would have to remain effective for at least two years. Cut-back bitumen at the rate of 1.2 l/m² has given 65% run-off and was still 7.5% intact after four years (Laing 1981). Therefore, after two years it may still be giving beneficial amounts of run-off. The effectiveness of a lower rate of bitumen has not been assessed. Plueddemann (1975) found that silicon emulsion was effective when bound with a polymer latex to give stability on the soil. Plueddemann cites Hillel (1976) that sodium methyl siliconate on large areas was 'fairly effective and surprisingly durable over a three year period, but it allowed soil erosion'. Such erosion may not be a problem on small individual tree catchments.

Cement is a readily available material, that is comparable in cost to bitumen (Table 1). Spreading cement onto sand, lightly raking it in and watering it was tried but was difficult to mix evenly in situ. A 1:4 premix of cement and sand (plus water) rendered over the soil gave a sealed surface.

The other methods and products mentioned in the literature are unsuitable for use because of unavailability, lack of suitability to the soil type under investigation, practicality of application, run-off effectiveness and price.

The following surface treatments and their costs are detailed below:

Product	Cost per m²
Bare soil	\$0.00
Silicone emulsion (Dow Corning® HV 490) plus polymer latex binder at 1:3 ration, diluted to 3% silicone solids and applied at 0.25 l/m²	\$0.29
Silicone emulsion (Dow Corning® HV 490) plus polymer latex binder at 1:3 ration, diluted to 1.5% silicone solids and applied at 0.25 l/m²	\$0.46
Sodium methyl siliconate (Dow Corning® 772) at 3% solids and applied at 0.25 l/m²	\$0.29
Cement render (5–8 mm)	\$0.58
Cut-back bitumen (Shell AMC 00) at 0.6 l/m²	\$0.30
Cut-back bitumen (Shell AMC 00) at 1.2 l/m²	\$0.60

Table 1. Cost of products (1993 Australian dollars)[2]

(iii) *Catchment formation*

Rainfall data was used to help decide the catchment area. The rainfall data at the Port Augusta power station (2 km from the trial site), had been kept from July 1985 to June 1988 (Table 2). It is doubtful whether the falls of 2 mm or less (62% of the total falls) would be worth harvesting because of evaporation and surface tension. Falls of 24 mm or more would be useful (maybe even damaging if concentrated on one spot). Somewhere between 2 and 24 mm the falls would become useful, depending on the size of the catchment as well as environmental conditions.

Another factor determining the usefulness of a fall is the amount of water placed near a seedling considered to be of benefit to that seedling. This could arbitrarily be set at 20 litres. The volume of water harvested by rainfall event is described by the following formula:

Volume (l) = Rainfall (mm) × catchment area (m²) × percentage run-off

Using this formula, the information in Table 2, and (as an example) the 65% run-off achieved with cut-back bitumen (Laing 1981), the following can be calculated:

Catchment area (m²)	Rainfall required (mm) to harvest 20l	Number of rainfall events in which 20l or more is likely to be harvested
1	30.8	0
2	15.4	4.9
3	10.3	8
4	7.9	9

[2] Mention of a trade name does not imply preference of a product.

Obviously one m^2 catchments would be of no use. Two m^2 catchments are unlikely to be an effective substitute for waterings because it is unlikely with erratic rainfall distribution of arid zones that the 4.9 beneficial rainfall events will occur at times critical to seedling survival. Three or four m^2 catchments would increase the chance of sufficient water being harvested to substitute for hand watering; to maximise this chance, 4 m^2 was used.

The soil was formed into a slope using a road grader. A 7% slope was used as this minimises bitumen redistribution (Plueddemann 1975). After the soil was graded, 2 × 2 m catchments were delineated with 200 × 2 mm galvanised metal strips on three sides and roof guttering on the lowest side. This delineation helped avoid run-on from the upslope and it set and kept the catchment shape constant. A lip of the guttering sat on the soil surface so that surface materials could be sprayed onto it and create a continuous flat surface from the soil to the guttering (Fig. 1). Residual herbicide (oxyfluorfen at 1.2 kg/ha a.i. and oryzalin at 2.5 kg/ha a.i.) was applied to each catchment prior to applying the surface treatments. However, the ground was dry at the time of application, which is not ideal for residual herbicides. Glyphosate at 1.08 kg/ha a.i. was used to control weed germination on the plots after application of the surface materials.

The guttering directed the run-off water into 45 L collection tank which were in excavated pits. Soil collapse into the pits was prevented by lining the pits with steel cylinders. A rain gauge was installed in the centre of the trial area.

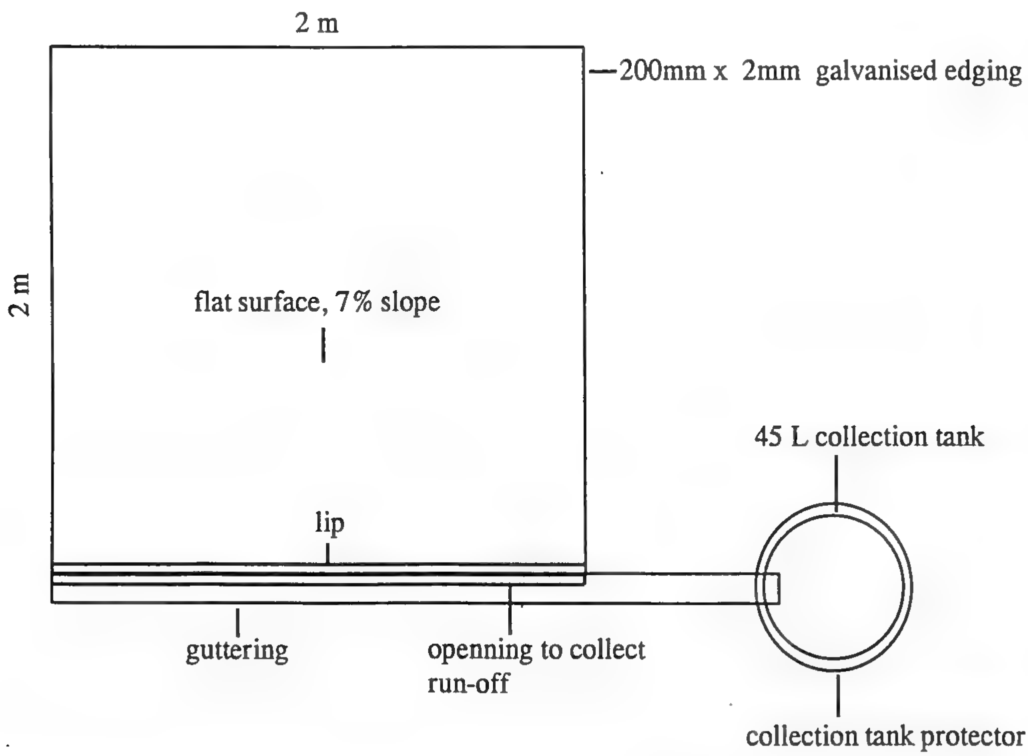

Fig. 1. Plan view of a 4 m^2 rainfall catchment showing edging, flat surface, guttering, lip, collection tank and collection tank protector.

(iv) *Design*

A randomised complete block design of three replicates, with two control treatments per replicate, was used. The rainfall reading and collection volume was measured at 9:00 a.m. daily, from the 1.v.1990 to the 28.ii.1991 to establish initial runoff, and from the 1.ii. to the 31.v.1992 to evaluate the effectiveness of the treatments after two years. Full collection tanks were recorded as 45+ l and less than 0.05 l was recorded as 0.

Rainfall range (mm)	Number of falls	Percentage of falls
< 1.0	40	48.8
1.1 – 2.0	10.3	12.6
2.1 – 3.0	7.3	8.9
3.1 – 4.0	4.7	5.7
4.1 – 5.0	4.3	5.2
5.1 – 6.0	2.0	2.4
6.1 – 7.0	2.7	3.3
7.1 – 8.0	1.7	2.1
8.1 – 9.0	0.3	0.4
9.1 –10.0	0.7	0.9
10.1 –12.0	1.7	2.1
12.1 –14.0	0.7	0.9
14.1 –16.0	0.7	0.9
16.1 –18.0	0.7	0.9
18.1 –20.0	1.3	1.6
20.01 –22.0	0.3	0.4
22.1 –24.0	0.3	0.4
>24.0	2.3	2.8
	82.0	

Table 2. Frequency of rainfall events of varying intensities (24 hour period). Average figures for the Port Augusta power station from July 1985 to June 1988.

Results and discussion

(i) *Effect of weeds*

Oxyfluorfen at 1.2 kg/ha a.i. (active ingredient) and oryzalin at 2.5 kg/ha a.i. controlled the weeds on the plots for nine months despite the dry soil at the time of application. After this large numbers of weeds emerged and broke up the bitumen, and to a lesser extent, the silicon crusts. Laing (1981, cited Kelsall 1968 and Laing & Prout 1975) reported that weed growth through bitumen catchments can destroy the catchment surface. The cement probably experienced less of a weed problem because it would have been more impermeable than other surface materials and too thick for weeds to penetrate, except through cracks.

(ii) *Annual rainfall*

A total of 175 mm of rain was recorded in the 12 months following the 1.v.1990. However, approximately 333 mm was recorded in the second 12 months. Fifty years of records from Port Augusta Post Office (1937 – June 1962 (2 km from trial site)) and Port Augusta Power Station (July 1962 – 1987) show that annual rainfalls of up to 175 mm only occur in 22% of years. Which means that higher rainfalls and greater run-off would have been received in 78% of years. Also, annual rainfalls of over 333 mm only occur in 12% of years (Bureau of Meteorology, Adelaide). The extremely wet second year of the trial may have contributed to an early deterioration of the surface materials.

(iii) *Initial poor treatments*

After four months measurements were discontinued on the silicon emulsion/latex treatments and the bare soil control plots because they were giving negligible run-off in comparison to the other treatments (Table 3). Poor results from these treatments may have been caused by permeability, or cracking in the surface before weed emergence became a problem, or surface tension withholding water. The silicon emulsion/latex treatments remained cracked from the start, possibly due to it being applied to dry soil. Attempts to seal the cracks with more silicon emulsion/latex were generally ineffective.

Plueddemann (1975) found that silicon emulsion was an effective surface sealant when bound with a polymer latex. However, his trial was conducted under controlled conditions.

Date		170590	210590	220590	230590	300590	120690	150690	160690	240690	300690
Rain (mm)		20	9	15	2	2	8.2	3	4	7.2	2.2
Rep	T										
1	1	45+	0.25	1.6	0	0	0.8	0.1	1.4	1.1	0
2	1	16.5	0.2	2.0	0	0	0.7	0.2	0.4	0.6	0
3	1	24.0	0	1.4	0	0	0.5	0	0.2	0	0
1	2	22.5	0.5	1.0	0.2	0.1	0.9	0.2	0.8	0.9	0.1
2	2	7.5	0.6	1.7	0	0	0.7	0.2	0.4	0.6	0
3	2	6.5	0.5	1.7	0	0	1.3	0.4	0.5	1.2	0
1	3	25.5	1.5	6.2	0.7	0	1.7	0.5	1.5	1.5	0
2	3	27.0	0.5	3.2	0	0	1.3	0.3	0.6	0.9	0
3	3	27.0	0.8	2.5	0.1	0	1.3	0.4	0.7	1.2	0
1	4	45+	10.5	36.0	2.0	1.0	9.0	2.6	5.8	9.2	1.0
2	4	45+	1.7	9.3	0.3	0.1	1.7	0.7	2.2	3.6	0.2
3	4	45+	3.3	8.0	0	1.1	5.8	1.9	5.0	10.5	1.2
1	5	45+	7.2	16.5	3.2	1.8	7.5	2.1	5.8	8.3	1.8
2	5	45+	6.8	18.3	3.3	2.5	10.6	2.7	7.3	11.2	2.5
3	5	45+	0.4	19.6	2.3	2.0	7.8	2.5	6.7	8.1	2.1
1	6	45+	12.2	28.0	2.5	1.5	7.5	1.8	2.5	6.6	1.4
2	6	45+	20.5	45+	3.6	2.4	7.8	3.3	6.2	9.6	2.4
3	6	45+	15.7	9.0	4.5	2.4	6.9	3.1	5.6	6.9	2.5
1	7	45+	32.0	45+	6.2	3.2	19.2	6.6	7.5	15.2	3.0
2	7	45+	21.3	45+	0.5	4.2	23.8	8.1	12.0	19.8	4.4
3	7	45+	4.0	9.2	4.4	3.1	17.5	4.0	6.7	13.8	3.2
1	8	29.5	0.3	1.5	0	0	0.9	0	1.1	0.6	0
2	8	45+	0.15	1.5	0	0	1.5	0.2	1.0	1.6	0
3	8	35.0	0.3	1.4	0	0	1.2	0	1.5	1.3	0

Table 3. Run-off (l) collected from each treatment and replicate for each rainfall event in the first year of the trial.

Note: 45 l is at over flow
Less than 50 ml is recorded as 0
Rep = replicate
T = Treatment:
1. Bare soil
2. Dow Corning® HV 490 (silicone emulsion) plus polymer latex binder at 1:3 ratio, diluted to 3% silicone solids.
3. Dow Corning® HV 490 (silicone emulsion) plus polymer latex binder at 1:3 ratio, diluted to 1.5% silicone solids.
4. Dow Corning® 772 (sodiummethyl siliconate) at 3% solids.
5. Cement render.
6. Cut-back bitumen at 0.6 l/m².
7. Cut-back bitumen at 1.2 l/m².
8. Bare soil.

DATE		020790	030790	070790	100790	120790	130790	200890	110990	071090	201090	091290	220191	230191
Rain (mm)		2	1.5	6	2	2.5	1	2.5	6.8	9	3	3	7	7
Rep	T													
1	1	0	0	0.4	0	0.1	0	0.1						
2	1	0	0	0.5	0	0.2	0	0.2						
3	1	0	0	0.6	0.1	0.2	0	0.2						
1	2	0.1	0	0.4	0.2	0.3	0.1	0.3						
2	2	0	0	0.2	0	0.2	0	0.2						
3	2	0.1	0	0.7	0.2	0.2	0	0.2						
1	3	0	0	0.25	0	0.3	0	0.3						
2	3	0	0	1.1	0	0.1	0	0.2						
3	3	0	0	0.5	0.1	0.2	0	0.2						
1	4	1.0	1.0	8.2	1.1	1.5	0	1.5	2.8	3.5	0	2.5	2.8	2.9
2	4	0.1	0	1.7	0.2	0.3	0.1	0.3	0	0.9	0	0.7	0.1	0.1
3	4	1.1	0.8	5.7	1.2	1.3	0.9	1.3	•	•	0	1.9	10.6	10.5
1	5	1.8	1.6	0.45	1.9	1.9	0	1.9	0	2.1	0	2.1	0.1	0.1
2	5	2.6	2.4	0.2	2.6	2.7	0	2.7	0.1	0.9	0	0.7	0.1	0.1
3	5	2.0	1.8	0.4	2.1	2.2	0	2.3	0.8	2.4	0	2.4	0.8	0.8
1	6	1.5	1.2	4.5	1.55	1.45	0.15	1.5	11.2	1.7	0	1.6	11.3	11.3
2	6	2.5	2.4	11.4	2.5	2.6	0.15	2.6	0.1	4.1	0	3.1	0.1	0.1
3	6	2.4	2.0	4.8	2.6	2.6	0.3	2.6	0.1	1.4	0	3.0	0.1	0.1
1	7	3.3	3.2	16.2	3.3	3.3	0.5	3.3	1.5	33.0	2.5	6.0	1.6	1.6
2	7	4.2	4.1	16.9	4.3	4.3	0.8	4.5	6.8	36.5	1.8	8.0	6.9	6.9
3	7	3.2	3.2	12.7	3.2	3.3	0.6	3.3	8.8	5.2	0	4.1	8.8	8.9
1	8	0	0	0.2	0	0	0	0.2						
2	8	0	0	0.2	0.1	0.1	0	0.1						
3	8	0	0	0.7	0.1	0.1	0	0.2						

Table 3 cont. Run-off (l) collected from each treatment and replicate for each rainfall event in the first year of the trial.

Note: 45 l is at over flow
Less than 50 ml is recorded as 0
Rep = replicate
T = Treatment:

1. Bare soil
2. Dow Corning® HV 490 (silicone emulsion) plus polymer latex binder at 1:3 ratio, diluted to 3% silicone solids.
3. Dow Corning® HV 490 (silicone emulsion) plus polymer latex binder at 1:3 ratio, diluted to 1.5% silicone solids.
4. Dow Corning® 772 (sodiummethyl siliconate) at 3% solids.
5. Cement render.
6. Cut-back bitumen at 0.6 l/m².
7. Cut-back bitumen at 1.2 l/m².
8. Bare soil.

DATE	COMMENTS
220590	Steady misty rain, 15–20 knot wind.
300590	Rain fell in two minutes.
150690	Rain in one heavy shower.
160690	Light misty rain over 12 hours.
240690	3 1-soil eroded from inside gutter edge.
100790	Light misty rain.
130790	Sprayed roundup® on weeds; light misty rain.

DATE	COMMENTS
200890	Misty showers, mild to warm.
110990	This is the first data with unrequired plots omitted. Lid from bin 3 4 is missing - presumed stolen.
071090	Lid on bin 3 4 still missing, but replaced from now on.
301090	Max temp = 39°C, winds in excess of 70 mph (at powerstation), thundery showers from N-NW.
091290	Cold with light drizzly rain.
220191	Temp = 38°C, high humidity.
230191	Temp = 31.5°, "cool change".

(iv) *Statistical analysis*

The coefficients of variation ranged from 114% to 160% for all treatments, precluding any mathematical model describing the percentage run-off in response to the rainfall amount. For this reason, all the data has been included in Table 3 & 4.

This variation may be caused by irregularity in rainfall distribution and/or evaporation over the trial area and/or leaks in some of the catchments and/or including varying degrees of damage due to weed emergence. Variation from one rainfall event to the next may be explained by different rainfall intensities or evaporation rates on the catchments and is illustrated in Tables 5.

Date		290292	010392	270392	060492	020592
Rain (mm)		14.5	99	5	15	20
Rep	Treatment					
1	4	1.7	45+	0.2	2.1	1.2
2	4	1.5	45+	0	1.4	0
3	4	3.2	45+	*	3.5	2.7
1	5	3.6	45+	1.4	4.7	5.5
2	5	8.3	45+	1.3	1.7	2.1
3	5	3.6	45+	1.9	11.1	4.8
1	6	2.4	45+	0	1.5	1.3
2	6	2.3	45+	0.2	2.6	2.2
3	6	2.2	45+	0.1	2.0	2.3
1	7	2.5	45+	0.9	4.6	1.6
2	7	7.8	45+	1.4	9.3	6.2
3	7	2.4	45+	0	2.5	1.5

Table 4. Run-off (l) collected from each treatment and replicate for each rainfall event in the last four months of the trial.

Note: 45 l is at over flow
Less than 50 ml is recorded as 0
Rep = replicate
Treatment:
4. Dow Corning® 772 (sodium methyl siliconate) at 3% solids.
5. Cement render.
6. Cut-back bitumen at 0.6 l/m².
7. Cut-back bitumen at 1.2 l/m².

Date	Rainfall (mm)	TREATMENT			
		Sodium methyl siliconate	Cement render	Bitumen @ 0.6l/m²	Bitumen @ 1.2l/m²
21/5/90	9	3.3	0.4	15.7	4.0
12/6/90	8.2	5.8	7.8	6.9	17.5

Table 5. Run-off volume harvested (l) from replicate 3 showing variability of results from one event to the next event of a similar rainfall quantity.

(v) *Cut-back bitumen effectiveness*

Despite the variation, cut-back bitumen at 1.2 l/m² tended to give more run-off than the other treatments. After the first four months there was a total of 51 measurements for each treatment (3 replicates × 17 rainfall events), 38 of which had cut-back bitumen at 1.2 L/m² returning the most run-off (Table 3). However, after two years the surface materials had deteriorated significantly, to the point where not even a 20 mm rainfall was giving the arbitrary target of approximately 20 l from any of the surface materials. The deterioration over time is illustrated by Table 6.

Date	Rainfall (mm)	Sodium methyl siliconate	TREATMENT		
			Cement render	Bitumen @ 0.6l/m²	Bitumen @ 1.2l/m²
22/5/90	15	17.7 (29.5%)	18.1 (30%)	27.3 (45.5%)	33.1 (55%)
29/2/92	14.5	2.1 (3.5%)	5.2 (9%)	2.3 (4%)	4.2 (7.25%)

Table 6. Run-off (l and %) means for the four best surface materials for rainfall events 21 months apart. Note the deterioration in run-off over time.

There were four events out of 23, between May 1990 and January 1991, which produced the arbitrary target of 20 l or more of run-off from the 1.2 l/m² cut-back bitumen catchments (Table 7). Despite being a drier than average year, according to Dalton's proposed watering formula[3], potentially three hand waterings would have been saved by using the 1.2 l/m² bitumen catchments (Table 7).

Although four events produced at least 20 l run-off, two of these events occurred in one month, resulting in only three hand waterings being saved. This represents a saving in hand-waterings to the value of $2.46 for that period (1993 dollars). Although the cost of treating one bitumen catchment @ 1.2 l/m² is $2.40 (1993 dollars) (Table 1), this still represents a potential saving of $0.06 per plant.

Despite only three hand waterings being saved directly, there would also still be a considerable benefit derived from the other run-offs of below 20 l. Therefore the potential savings and value could be higher.

With 100% run-off of the rainfall listed in Table 7 (125.9 mm) a total of 503.6 l would have been caught from one 4 m² catchment in the first year of the trial. However, an average of 240 l was caught from the 1.2 l/m² of cut-back bitumen catchments (Table 7), which is 48% of the maximum possible run-off. After 21 months this had been reduced to less than 10% (Table 6). This is less than Laing 1981, who found that cut-back bitumen at the rate of 1.2 l/m² was giving 65% run-off and was still 7.5% intact after four years.

The 0.6 l/m² cut-back bitumen, although it cannot be statistically verified, was not producing as much run-off as the higher rate (Table 3 & 4). However, it was producing more run-off than the sodium methyl siliconate and cement in the first year of the trial. The 0.6 l/m² cut-back bitumen catchments experienced only one month throughout the trial in which a hand watering could potentially be saved. As it costs $1.20 to treat one catchment with 0.6 l/m² of cut-back bitumen and only one watering was spared, at a saving of $0.82, then this treatment cost an extra $0.38 per plant to use.

The low rate of bitumen tended to get ant holes, and germination of weeds were worse than any other treatment. In December 1990 the surface was showing marked signs of breaking up.

(vi) *Run-off threshold*

Referring to Table 3, although 1 mm of rain was producing run-off in the first year from 1.2 l/m² of cut-back bitumen, the quantities were not considered to be useful. Two mm of rain most often produced 3–4 l of run-off in the first year, which would have a minor effect by itself. However, if (depending on intensity) it falls close to a few other small events or one large event then 2 mm would be of some use.

[3] As per Introduction: water with 40 litres every 28 days, but if 25 mm or more of rain occurs within a two day period, then defer the watering until 28 days after this rain.

(vii) *Catchment size*

Considering the value of 2 mm rainfall events, the four events which gave in excess of 20 L run-off in the first year and the potential for substantial cost savings with the 1.2 l/m² cut-back bitumen catchments, as well as the likelihood of better years of rainfall than that of the first year of the trial, the area of 4 m² for catchments appears to be satisfactory. The catchments could be even more effective if the first year's percentage run-off could be maintained for two years.

(viii) *Sodium methyl siliconate and cement effectiveness*

Although the sodium methyl siliconate water repellent is reasonably priced (Table 2) it is toxic to handle, which forces operators to wear fully protective clothing and equipment. This can make application of this product uncomfortable during warm weather conditions, which are common in the arid zone. Also, this product appears to give less run-off than the bitumen treatments from rainfalls of less than 15 mm (Table 3 & 4). After eight months the 772 plots were showing signs of soil erosion, which can be a problem with this treatment (Plueddemann 1975).

Creating the cement render means that a considerable amount of time and effort is spent on each cement catchment, making it impractical to use for most projects. The cost of the product (Table 2) on top of labour costs further limits its suitability. Also, cement generally seemed to give low levels of run-off in the first year of the trial, in comparison to bitumen. However, it was marginally more durable than 1.2 l/m² of cut-back bitumen over the two years, but still unsatisfactory (Table 4). However this result is supported by Hudson (1987), who also noted that cement gave poorer levels of run-off than expected. This may be caused by evaporation, water disappearing down cracks in the surface or unevenness in the surface retaining water.

Month	Rainfall mm	Run-off mean (l)	Hand-watering necessary considering: run-off	rainfall only
May	20	45		*
	9	19		
	15	33		
	2	3.7		
	2	3.5		
June	8.2	20		*
	3	6		
	4	9		
	7.2	16		
	2.2	3.5		
July	2	3.5	*	*
	1.5	3.5		
	6	15		
	2	3.5		
	2.5	3.5		
	1	<1		
August	2.5	3.5	*	*
September	6.8	5.7	*	*
October	9	25		*
	3	1.5		
November	-	-	*	*
December	3	6	*	*
January	7	6	*	*
	7	6		
February	-	-	*	*
March	-	-	*	*
TOTAL	**125.9**	**240**		

Table 7. The mean run-off from the 1.2 l/m² cut-back bitumen treatment for each rainfall event in the first year. It also indicates whether hand-watering would be necessary each month, on the basis of the formula proposed by Dalton[4], with and without the caught run-off, considering the amount of rainfall during each month and the arbitrary target of approximately 20 l from rainfall catchments, which are discussed above.

[4] As per Introduction: water with 40 litres every 28 days, but if 25 mm or more of rain occurs within a two day period, then defer the watering until 28 days after this rain.

Conclusions

Cut-back bitumen at 1.2 l/m² is the most promising treatment for enhancing run-off. While bitumen is costly to apply at this rate in comparison to most other treatments (Table 2) and is difficult to apply it still returned a potential nett cost saving during the period of the trial. Cut-back bitumen at 0.6 L/m² has doubtful potential for effective rainfall harvesting over two years.

Better weed control into the second year would have resulted in much less damage to the catchments and higher levels of run-off over two years, especially from the cut-back bitumen treatments. Dry soil at the time of the application of the surface treatments may have contributed to a more rapid degradation which could be expected of many of the surfaces.

If rainfall harvesting on sandy soil is to be a reliable method of reducing the cost of tree establishment in the arid zone, weed control must be maintained for two years and a damp soil surface should be ensured before application of surface treatments.

On the basis of low run-off, cost, toxicity, rapid degradation and impractical application the following treatments should be excluded from recommendations and further trials for catchment enhancement: sodium methyl siliconate, cement, cut-back bitumen at 0.6 l/m² and bare soil. Silicon emulsion/latex may give better results if applied to damp soil, therefore should not be excluded from future work.

For practical purposes, rainfall catchments should be made with a grader, such that when it is travelling, the blade is lowered then raised to form a 4 m² scoop of 7% slope which would direct run-off to one plant. Using a grader to make catchments would be less time consuming and cheaper than creating basins for water carting or installing driplines.

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A TAXONOMIC REVISION OF *APHELIA* (CENTROLEPIDACEAE)

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Abstract

The endemic Australian genus *Aphelia* is revised. Six species – *A. brizula, A. cyperoides, A. drummondii, A. gracilis, A. nutans* and *A. pumilio* – are distinguished on morphological features. The removal of any of these species to the segregate genus *Brizula* is not supported.

Introduction

Aphelia R. Br. is an endemic Australian genus of Centrolepidaceae characterised by its inflorescence: a spike, superficially resembling the spikelet of Cyperaceae, with distichous bracts enclosing unisexual florets. The florets are never fused to form pseudanthia, in contrast to the two other genera of the family, *Centrolepis* and *Gaimardia*. Robert Brown (1810) originally described this genus with a single species, *A. cyperoides*, and included it with other centrolepids and restiads in his concept of the family 'Restiaceae'.

Sonder (1856) added the two eastern Australian species, *A. gracilis* and *A. pumilio*, and Mueller (1866) described *A. brizula* from Western Australia. Hieronymus (1872) established the segregate genus *Brizula*: this was differentiated as having all the male florets grouped in the lowest one or two bracts of the inflorescence, with only female florets in the distal bracts. In his revision of the Centrolepidaceae, Hieronymus (1873) retained only *A. cyperoides* in *Aphelia* but added *Aphelia monogyna*, based on *Alepyrum monogynum* J.D. Hook., on the grounds that both of these otherwise disparate plants have a solitary male and female floret in each bract. Bentham (1878) restored all species of *Brizula* to *Aphelia* and added one more species, the rarely collected *A. nutans*. His concept of the genus is maintained in the present paper.

Ecology

All *Aphelia* species are winter-growing annuals, confined to the zone of southern Australia with reliable winter rainfall and a summer water deficit. Like the annual *Centrolepis* species (Cooke, 1992), *Aphelia* species have a reduced structure adapted to habitats where seasonal rainfall defines the growing season and growth within this period is further limited by the availability of nutrients. They may be categorised as stress-tolerant ruderals (in the system of Grime, 1979); their reduced and condensed structure is associated with the short growing season and limited resources. They occupy a range of microhabitats from the margins of seasonal freshwater pools to the sparse herb stratum in heath, scrub or woodland communities, but are absent from forests and other vegetation with a dense shading canopy.

In populations of an annual plant (Cooke 1992), seed production per individual provides a rough measure of the parameter *r* (the intrinsic rate of increase). This quantity may be estimated from the range of available herbarium material as l_n (median number of seeds/inflorescence X median number of inflorescences/plant); it is only an approximation of *r*, since the generations may overlap due to delayed germination of seeds forming a seed bank in the soil, and also because viability may not be uniform. Among annual *Centrolepis* species this value ranges from 2.4 to 8.1, corresponding to a wide gradation from species specialised for stress-tolerator niches to ruderal (sensu Grime) species with seed production several orders of magnitude higher (Cooke, 1992). In contrast, the six species of *Aphelia*

yielded values between 4.0 and 4.6 (Table 1), implying a more uniform stress-tolerant ruderal strategy throughout this genus.

A. gracilis	4.0
A. nutans	4.0
A. pumilio	4.0
A. drummondii	4.4
A. brizula	4.4
A. cyperoides	4.6

Table 1. *Aphelia* species listed by 1_n seed number/plant.

Morphology

Leaves

On the anatomical evidence summarised by Cutler (1969), I have previously considered the types of leaf and bract developed in Centrolepidaceae as a reduction series from a linear phyllome with an open sheathing base and a photosynthetic lamina, and originally containing three parallel vascular bundles (Cooke, 1992).

In all *Aphelia* species, each basal leaf consists of an open membranous sheath and a linear herbaceous lamina. They may have been derived from the distichous and subequitant type of leaf that appears to be plesiomorphic in *Centrolepis* and the Restionaceae, and they remain manifestly distichous in *A. cyperoides*. As in the related genera *Centrolepis* and *Gaimardia*, the last leaf produced before the scape and inflorescence is usually reduced: its lamina is shortened or completely suppressed, leaving the sheath as a small membranous cataphyll.

Inflorescence

The inflorescence of *Aphelia* has the form of a spike with the primary axis, here called the rachis, bearing several distichous herbaceous bracts. Each of these bracts encloses a sessile part-inflorescence that may be reduced to a single female or male floret. Although highly condensed by the suppression of internodes, those part-inflorescences that contain more than one floret are recognisable as cincinni (Hamann, 1962).

The whole inflorescence could be interpreted either as a thyrse, with a monopodial rachis bearing axillary cymes (Hamann, 1962), or as a compound cymose inflorescence in which the first order of branching has become a pseudomonopodium as a consequence of forming a compact imbricate structure. In other words, it may be regarded as one florescence (within a polytelic system comprising the whole plant) made up of axillary partial florescences, or as a monotelic inflorescence made up of axillary paracladia (sensu Troll, 1964).

The question of whether the rachis of *Aphelia* is a true monopodium may be one of terminology rather than substance, because all determinate monopodial inflorescences may derive ultimately from sympodial branching systems. However, the first interpretation assumes an extra degree of complexity in development because the higher orders of branching in centrolepid inflorescences are all clearly cymose (Hieronymus, 1886; Hamann, 1962; Cooke, 1980). The second interpretation is a more parsimonious alternative and is also consistent with the zig-zag, flexuose form of the rachis seen in all *Aphelia* species.

The first one or two bracts in the spike of *Aphelia* are differentiated, and are here termed the primary bracts. They are phyllomes with the bases modified to enclose part-inflorescences consisting wholly or mainly of male florets, and often bear short laminae

similar to those of the leaves, as do the two primary bracts of many *Centrolepis* species. The succeeding distichous bracts are also herbaceous but are reduced to the sheath, and in most species each encloses a solitary female floret only; at the fruiting stage each bract clasps the enclosed fruit and is shed with it. Because they subtend higher orders of branching within the inflorescence than do the primary bracts, these succeeding bracts are more closely homologous to the secondary bracts that occur between the pseudanthia of some *Centrolepis* species (Cooke, 1980) than to the two primary bracts of that genus. They are therefore termed "distal bracts" in this paper. The alternative view (Hamann, 1962) treats both the distal and primary bracts as equivalent and serially homologous organs along one monopodial axis.

The secondary bracts that subtend branches within the part-inflorescences of *Aphelia* are further reduced to hyaline scales one cell thick and without vascular tissue; they are homologous to the secondary bracts directly associated with the unisexual florets of *Centrolepis*.

The individual male and female florets of *Aphelia* are reduced respectively to solitary stamens and unicarpellate pistils showing little morphological variation between species. They are similar to the unisexual florets of *Centrolepis* and *Gaimardia*, but are never fused into pseudanthia: this may be either a plesiomorphy retained by the genus or the result of a reduction series parallel to that seen in *Centrolepis* species such as *C. monogyna*.

In all *Aphelia* species each male floret is subtended by a secondary bract on its dorsal side, i.e. the secondary bract is opposed to the primary or distal bract that encloses the part-inflorescence. In *A.brizula*, *A. cyperoides*, *A. drummondii* and *A. pumilio* there is also a secondary bract on the dorsal side of each of the solitary female florets. In *A. gracilis* and *A. nutans* this bract is either absent or vestigial.

Fruit and seed

The fruit, a tardily dehiscent follicle with a thin pericarp enclosing one seed, is similar in all species. Each distal bract abscisses from the rachis carrying the fruit that it clasps; this adaptation of the inflorescence for passive dispersal occurs in all species. The hairs on these bracts may give them some potential to adhere to the fur of animals for longer range dispersal. The testa is thin and without sculpture.

Vestiture

All trichomes produced by *Aphelia* species are uniseriate eglandular hairs, each developed from a basal epidermal cell as an unbranched chain of 2–5 empty, thin-walled cylindrical cells; in most species they are restricted to the distal bracts. In *A. gracilis* the distal bracts bear straight hairs 0.03–0.06 mm wide similar to those of *Centrolepis* species, but two distinctive hair types occur in other *Aphelia* species. In *A. cyperoides* the terminal cell of each hair is minutely hooked at the apex or appears circinnate due to more extensive spiral curvature. *A. brizula*, *A. drummondii* and *A. pumilio* have a crest of modified hairs along the keel of the distal bracts. The lowest cell of each hair is enlarged and the succeeding cells are reduced in number and size; in *A. drummondii* each hair is further reduced to a single inflated tooth-like basal cell.

Relationships

If an assumption of a general trend to reduction in structure is correct, *A. cyperoides* would be the most primitive member of the genus because of its three-veined distichous leaves, spike not divisible into male and female sections and unspecialised leaf-like primary bracts. It is also unique in bearing circinnate or hooked hairs. However, considering the homogeneity of *Aphelia* sens. lat. and its distinctness in inflorescence structure – with

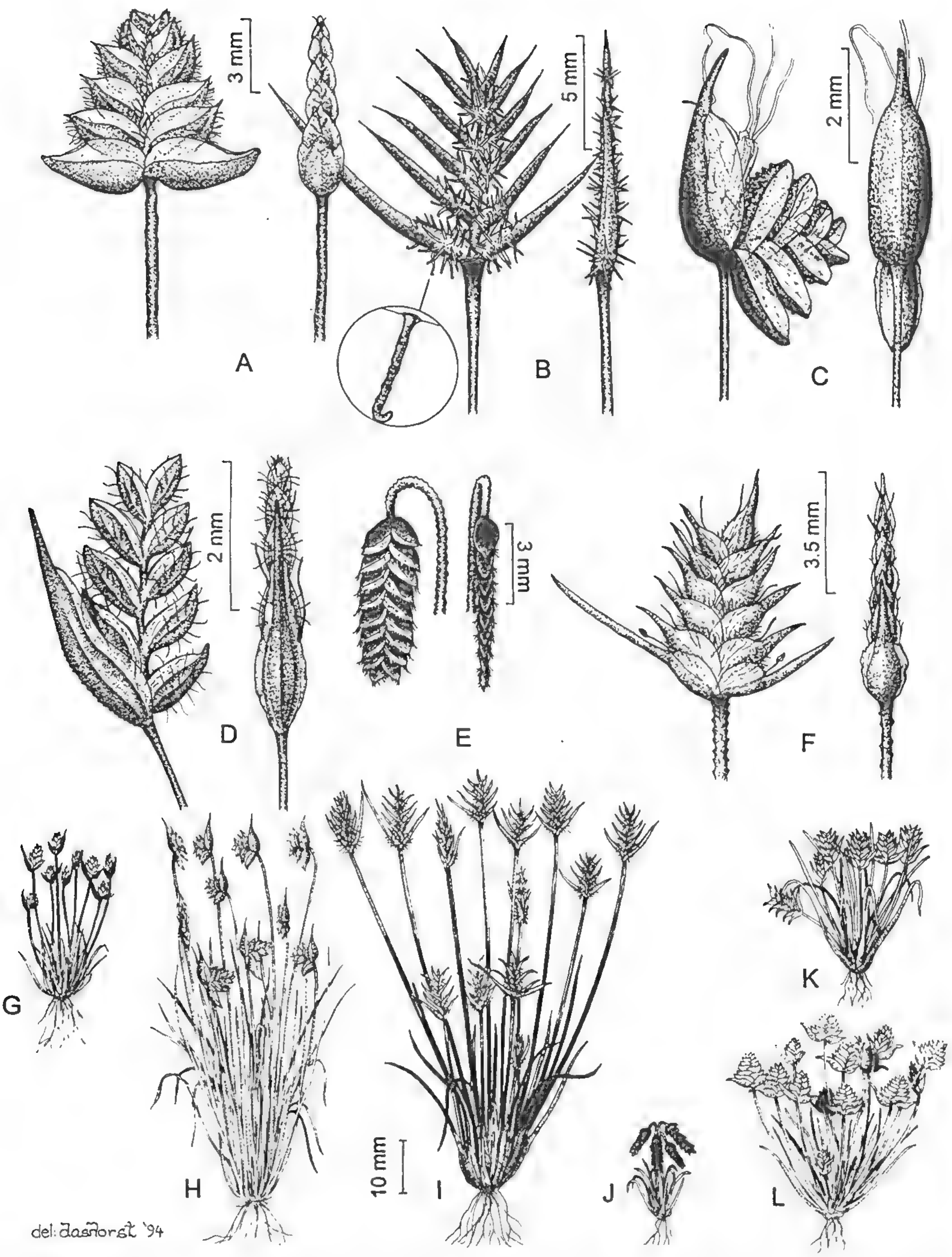


Fig. 1. *A. brizula* (*Donner 2892*). A, inflorescence; L, habit ×1. *A. cyperoides* (*Carrick 8859*). B, inflorescence; I, habit ×1. *A. drummondii* (*Butler s.n.* PERTH). C, inflorescence; H, habit ×1. *A. gracilis* (*Eichler 17077*). D, inflorescence; G, habit ×1. *A. nutans* (*Eichler 20348*). E, inflorescence; J, habit ×1. *A. pumilio* (*Spooner 296*). F, inflorescence; K, habit ×1.

distichous secondary bracts, each enclosing a single seed and shed with it - from the other genera of Centrolepidaceae, it appears preferable to retain all six species in one genus.

Although four species are restricted to Western Australia and the others to the south-eastern States, the genus is not divisible into eastern and western groups. It is appears likely that *Aphelia* underwent most of its evolution before the winter-rainfall region of south-western Australia became isolated from the corresponding zone of eastern Australia by increasing aridity.

APHELIA R. Br.

Aphelia R. Br., Prodr. 251 (1810); Roemer & Schultes, Syst. Nat. 1: 43 (1817); Endl., Gen. Pl. 120 (1836); Kunth, Enum. Pl. 3:489 (1841); Nees in Lehm., Pl. Preiss. 2: 71 (1846); Steud., Syn. Pl. Glum. 2: 266 (1855); J.D. Hook., Fl. Tasman. 2: 75 (1858); F. Muell., Fragm. Phyt. Aust. 5: 203 (1866); Hieron., Abh. Naturf. Ges. Halle 12: 208 (1873) *pro parte*; Benth., Fl. Austral. 7: 200 (1878); Benth. & J.D. Hook., Gen. Pl. 3: 1026 (1883); Hieron., Pflanzenfam. 2(4): 15 (1888); Baillon, Hist. Pl. 12: 133 (1892); Rodway, Tasm. Fl. 231 (1903); Ewart, Fl. Vict. 260 (1931); J. Black, Fl. S. Aust. 2nd edn 1: 177 (1943); Hutchinson, Fam. Fl. Pl. 2nd edn 2: 700 (1959); D. Cooke in Jessop & Toelken, Fl. S. Aust. 4: 1823 (1986); Rye in Marchant *et al.*, Fl. Perth Reg. 2: 294 (1987).

Type species: *A. cyperoides* R. Br.

Brizula Hieron., Bot. Zeit. 30: 206 (1872); Abh. Naturf. Ges. Halle 12: 206 (1873); F. Muell., Fragm. Phyt. Aust. 8: 237 (1874); Hieron., Pflanzenfam. 2(4): 15 (1888); J. Black, Fl. S. Aust. 1: 101 (1922); Hutchinson, Fam. Fl. Pl. 2nd edn 2: 700 (1959); Hamann in Melchior, Syll. Pflanzenfam. 2: 559 (1964); Hamann, Bot. Jahrb. Syst. 96: 158 (1975).

Type species: *B. muelleri* Hieron. Hieronymus (1872) wrote in the plural that "diese Arten unterscheiden sich von ... *Aphelia cyperoides* R. Br." but did not name any species in the new genus. It is possible that he based his generic concept on *A. brizula*, *A. drummondii*, *A. gracilis* and *A. pumilio* because *Brizula* comprised these four species in his revision, published in the following year. *Brizula muelleri* is here chosen as the lectotype because it was an avowed synonym for *Aphelia brizula*; since Hieronymus derived the generic name from this epithet, it is certain that at the time of the protologue his concept of the genus included at least this species.

Aphelia Hieron., Abh. Naturf. Ges. Halle 12: 208 (1873), *pro parte*.

Alephia Dumort., Anal. Fam. Pl. 63 (1829), *sphalm. orthog.*

Small terrestrial annual herbs. *Root system* fibrous with few to many adventitious roots from the leaf axils, few-branched or unbranched. *Rhizome* absent; *stem* extremely short, compactly branching with internodes of negligible length. *Leaves* all basal, 1–3-veined, linear to subulate with somewhat dilated open membranous sheathing bases; ligule absent. Uppermost leaf usually reduced to a membranous cataphyll. *Scapes* terminal, erect, terete, consisting of a single internode. *Inflorescence* a terminal laterally compressed spike with distichous, 3-veined, herbaceous bracts each enclosing a sessile condensed cincinnus of 1–8 unisexual florets; rachis flexuose, often concealed by the bracts. *Primary bracts* 1–2, differentiated from distal bracts, usually with apices similar to laminae of leaves. *Distal bracts* 4–16, all similar, successively reduced in size, imbricate at anthesis, each ultimately clasping a solitary enclosed fruit and shed with it. *Secondary bracts* concealed, short, veinless, hyaline, entire or minutely erose, solitary on the dorsal side of each male, and sometimes female, floret. *Male floret* a solitary stamen; filament capillary, glabrous; anther shortly exserted, dorsifixed, versatile, unilocular, ellipsoid to ovoid, dehiscing by a longitudinal slit. *Female floret* a solitary carpel, shortly stipitate; ovary fusiform, unilocular with 1 pendulous orthotropous ovule, hyaline, glabrous; style terminal, filiform, exserted, persistent, with unbranched stigmatic papillae all along the adaxial side. *Fruit* a dry

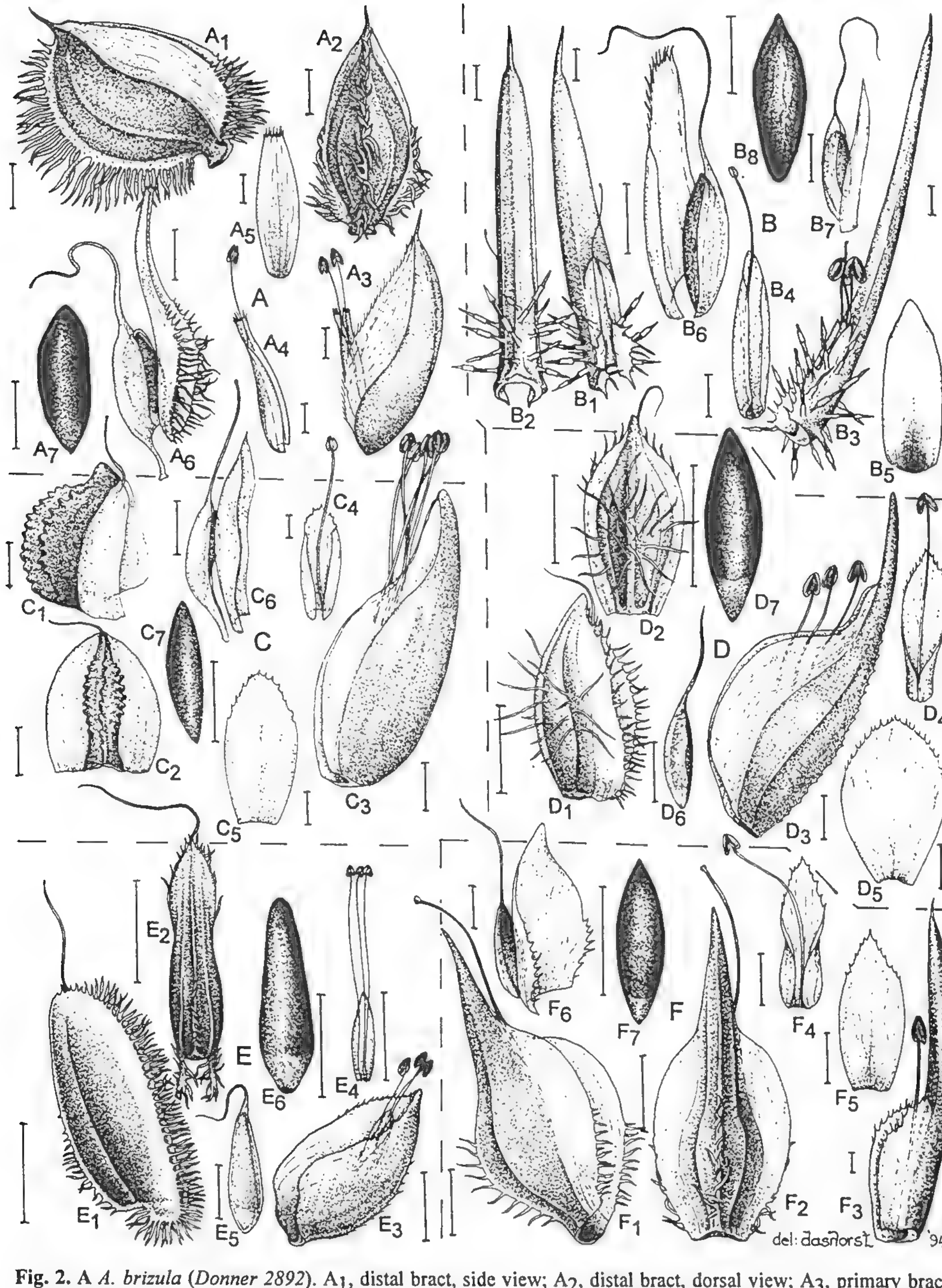


Fig. 2. **A** *A. brizula* (*Donner 2892*). A_1, distal bract, side view; A_2, distal bract, dorsal view; A_3, primary bract with male flowers; A_4, male floret with secondary bract; A_5, secondary bract; A_6, female floret with secondary bract; A_7, seed. **B** *A. cyperoides* (*Carrick 8859*). B_1, distal bract, ventral view; B_2, distal bract, dorsal view; B_3, primary bract with male florets; B_4, male floret with secondary bract; B_5, secondary bract; B_6, female floret from axil of primary bract, with secondary bract; B_7, female floret from axil of distal bract, with secondary bract; B_8, seed. **C** *A. drummondii* (*Butler s.n.* PERTH). C_1, distal bract, side view; C_2, distal bract, dorsal view; C_3,

membranous 1-seeded follicle dehiscing by an adaxial slit. *Seed* usually retained within fruit and bract, fusiform, endospermic with a small apical embryo; testa smooth, membranous.

A genus of 6 species endemic to southern Australia.

Key to species

1. Scape decurved at apex; spike pendulous .... 2. *A. nutans*
1: Scape straight; spike erect or oblique 2

2. Spike oblique, asymmetric; primary bract 1 3
2: Spike erect, symmetric; primary bracts 2 4

3. Distal bracts without keel; margins ciliolate .... 3. *A. gracilis*
3: Distal bracts with a cristate keel; margins entire .... 6. *A. drummondii*

4. Spike becoming lax by growth of rachis; distal bracts pilose, the hairs not confined to keel ...... 1. *A. cyperoides*
4: Spike remaining compact; distal bracts with hairs on the keel only 5

5. Distal bracts ovate, prominently mucronate, with hyaline margins extending about halfway to the apex .... 4. *A. pumilio*
5: Distal bracts broad-ovate, shortly apiculate, with hyaline margins extending to the apex .... 5. *A. brizula*

1. **Aphelia cyperoides** R. Br., Prodr. 252 (1810); Roemer & Schultes, Syst. Nat. 1: 43 (1817); Desv., Ann. Sci. Nat. (Paris) 13: 42 (1828); Kunth, Enum. Pl. 3: 488 (1841); Nees in Lehm., Pl. Preiss. 2: 71 (1846); Steud., Syn. Pl. Glum. 2: 266 (1855); Hieron., Abh. Naturf. Ges. Halle 12: 208 (1873); F. Muell., Fragm. Phyt. Aust. 8: 236 (1874); Benth., Fl. Austral. 7: 200 (1878); Baillon, Hist. Pl. 12: 128 (1892); Blackall & Grieve, West. Aust. Wildfls 1: 59 (1954); Rye in Marchant et al., Fl. Perth Reg. 2: 294 (1987).

Type: Oyster Harbour, King Georges Sound [W.A.], xii.1801, *R. Brown* sub Bennett No.5826 (lecto. here chosen because it includes most of Brown's material with his annotations: BM!; isolecto.: MEL 535279! CANB 67858!)

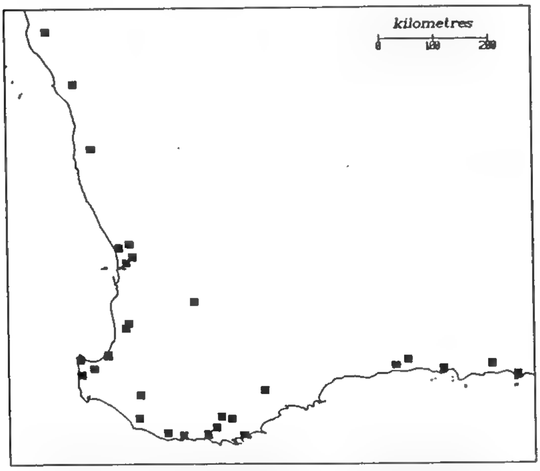
–var. *minor* Hieron., Abh. Naturf. Ges. Halle 12: 208 (1873).
Type: no locality [W.A.], *J. Drummond s.n.* (holo.: B n.v.; iso.: MEL 577849!)

Tufted annual herb 1–15 cm high, remaining light green at flowering. *Leaves* manifestly distichous, 2–3-veined; *sheath* membranous to hyaline, 2.5–10 mm long, glabrous or rarely strigose, passing abruptly into a slightly recurved keeled linear-subulate glabrous lamina 0.5–5 cm long, c. 0.6 mm wide; apex acute, mucronate. *Cataphyll* 2–10 mm long, acute to obtuse, rarely absent. *Scape* straight, erecto-patent, 1–16 cm long, glabrous. *Spike* erect, slightly asymmetric, triangular to rhomboid, 5–13 mm long, 5–12 mm wide; rachis accrescent and becoming exposed in fruit. *Primary bracts* two, with entire margins and spreading leaf-like apices, glabrous or sparsely pilose on sheath, each enclosing 1–2 male florets sometimes with 1 female floret, the lower bract 6–11 mm long, the second shorter. *Distal bracts* 5–14, lanceolate-cymbiform, acute, 3–6 mm long, with rounded backs densely pilose except near the midline and narrow, ciliolate margins becoming incurved in fruit,

primary bract with male florets; C_4, male floret with secondary bract; C_5, secondary bract; C_6, female floret with secondary bract; C_7, seed. **D** *A. gracilis* (*Eichler 17077*). D_1, distal bract, side view; D_2, distal bract, dorsal view; D_3, primary bract with male florets; D_4, male floret with secondary bract; D_5, secondary bract; D_6, female floret; D_7, seed. **E** *A. nutans* (*Eichler 20348*). E_1, distal bract, side view; E_2, distal bract, dorsal view; E_3, primary bract with male florets; E_4, three male florets with one secondary bract; E_5, female floret; E_6, seed. **F** *A. pumilio* (*Spooner 296*). F_1, distal bract, side view; F_2, distal bract, dorsal view; F_3, primary bract with male florets; F_4, male floret with secondary bract; F_5, secondary bract; F_6, female floret with secondary bract; F_7, seed. (Scale 0.5 mm.)

each enclosing 0–1 male floret and 1 female floret. *Stamens* each subtended by a lanceolate, acute, secondary bract c. 2 mm long; filament 2–3 mm long; anther oblong-ellipsoid, 0.7–1.5 mm long. *Ovary* c. 1 mm long; style 2.5–3.5 mm long; secondary bract lanceolate, 1–2 mm long. *Seed* 1.0–1.3 mm long; testa pale brown. (Fig. 1B, I; 2B)

Distribution (Map 1)



Map 1. Distribution of *Aphelia cyperoides* in south-western WA.

Western Australia: Widespread from Greenough River south to Albany and east to Cape Arid, in the Irwin, Darling, Avon, Eyre and Rowe botanical districts of Beard (1980).

Ecology

Winter annual of moist open sites in heath and woodland, on swamp margins and lithoseral moss beds. Flowers September to November.

Notes

The variety *minor* was based on a depauperate specimen among the few collections examined by Hieronymus, and differs from typical *A. cyperoides* only in the size of most organs and the number of distal bracts. These characters vary widely and continuously within the species according to habitat conditions, and therefore I have not recognised the variety.

Selected specimens examined (total 62)

WESTERN AUSTRALIA: near Moates lake W of Two Peoples Bay, 21.x.1983, *Corrick 8859* (AD; MEL); Young River crossing 5 km N Neds Corner, 27.ix.1968, *Donner 2813* (AD; PERTH); 8 km S Eneabba, 28.ix.1979, *Hnatiuk 790062* (PERTH); Lort River crossing, Ravensthorpe-Esperance road, 11.ix.1968, *Jackson 1396* (AD; PERTH); Howatharra Hills, 27.viii.1980, *Keighery 3237* (PERTH); 3 km N Yallingup, 7.x.1981, *Keighery 4046* (PERTH); Manjimup, xi.1920, *Koch 2497* (PERTH); Serpentine River, 1.xii.1877, *Mueller* (MEL); c. 20 km S of Ongerup, *Newbey 4509* (PERTH); c. 10 km W of Cookernup, 5.xii.1974, *Pullen 9831* (CANB); c. 7 km S of Capel, 5.xii.1974, *Pullen 9846* (CANB); Mt Chudalup, 9.x.1966, *Scrymgeour 1602* (PERTH); Porongorup Ranges N.P., 6.x.1978, *Spencer 2* (MEL); between Cowaramup and Margaret River, 6.xi.1974, *Whibley 5049* (AD; PERTH).

2. **Aphelia nutans** J.D.Hook. ex Benth., Fl. Austral. 7: 200 (1878); Rye in Marchant et al., Fl.Perth Reg. 2: 924 (1987).

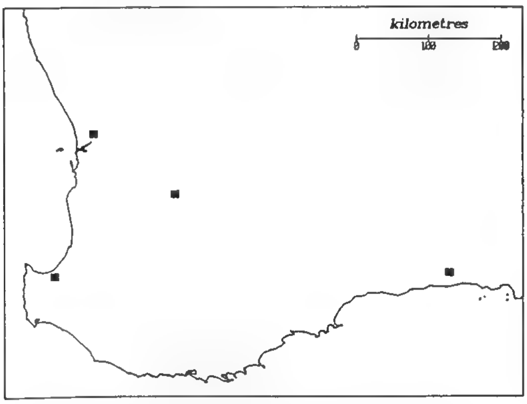
Type: W. Australia, *J. Drummond suppl. 84* (holo.: K n.v.).

Brizula nutans (J.D. Hook. ex Benth.) C. Gardner, Enum Pl. Aust. Occ. 1: 17 (1930); Blackall & Grieve, West. Aust. Wildfls 1: 58 (1954); Beard, Descript. Cat. W. Aust. Pl. 8 (1965).

Annual herb 1.2–3.5 cm high, becoming purple-pigmented at flowering. *Leaves* obscurely distichous, 1-veined, glabrous; sheath 1–2 mm long, hyaline, passing into a recurved linear-subulate terete lamina 2–9 mm long, c. 0.15 mm wide; apex subacute, apiculate. *Cataphyll* obtuse, c. 1 mm long. Scape abruptly recurved at apex, 0.9–3 cm long, glabrous. *Spike* pendulous, symmetric, oblong-lanceolate, 3–8 mm long, 2–2.5 mm wide, becoming looser in fruit; rachis slightly accrescent. *Primary bracts* two, equal, broad-ovate, acute, 1.2–1.6 mm long, glabrous, each enclosing 2–4 male florets; backs rounded, smooth; margins broad, membranous, entire. *Distal bracts* 6–16, oblong, obtuse, 1–1.8 mm long,

each enclosing one female floret; backs rounded, smooth, or rarely scaberulous on midline near base; margins broad, hyaline to the apex, ciliolate, imbricate at base, becoming incurved in fruit. *Stamens* each subtended by a narrow-lanceolate, acute secondary bract 0.3–0.5 mm long; filament 1.5–2 mm long; anther elliptic, 0.5–0.7 mm long. *Ovary* c. 1 mm long; style c. 0.8 mm long; secondary bract absent or vestigial. *Seed* c. 0.9 mm long; testa pale brown. (Fig. 1E, J; 2E)

Distribution (Map 2)



Map 2. Distribution of *Aphelia nutans* in south-western WA.

Western Australia: Scattered and apparently disjunct in the southwest, where collected from four localities only, in the Darling, Avon and Eyre botanical districts.

Ecology

Winter annual of moist microhabitats such as moss swales and swampy sands. Flowers September, October.

Specimens examined (total 4)

WESTERN AUSTRALIA: near Young River, 21 km NNW Stokes Inlet, 20.x.1968, *Eichler 20348* (AD, PERTH); Yoongarillup, 16.x.1950, *Royce 3374* (PERTH); Tutanning Reserve, 20.ix.1962, *Royce 7653* (PERTH).

3. **Aphelia gracilis** Sonder, Linnaea 28: 227 (1856); F. Muell., Fragm. Phyt. Aust. 5: 204 (1866); Benth., Fl. Austral. 7: 201 (1878); C. Moore, Handb. Fl. N.S.W. 441 (1893); Rodway, Tasm. Fl. 231 (1903); Ewart, Fl. Vict. 259 (1931); J. Black, Fl. S. Aust. 1: 177 (1943); J.H. Willis, Handb. Pl. Vict. 1: 277 (1962); Cooke, Fl. S. Aust. 4: 1824 (1986); E. Brown, Fl. N.S.W. 4: 408 (1993).

Type: Australia felix [western Victoria], *F. Mueller* (lecto. here chosen because it is the most typical and best preserved specimen: MEL 558047! ex herb. Sonder); Echinsuga [Echunga, S.A.], xi.1848, *F.Mueller* (syn.: MEL 577702 pro parte!, a mixed sheet with another Mueller collection from Onkaparinga); Van Diemensland [Tasmania], 1848, *C. Stuart* (syn.: MEL!).

Brizula gracilis (Sonder)Hieron., Abh. Naturf. Ges. Halle 12: 206 (1873); F. Muell., Fragm. Phyt. Aust. 8: 237 (1874); J. Black, Fl. S. Aust. 1: 101 (1922).

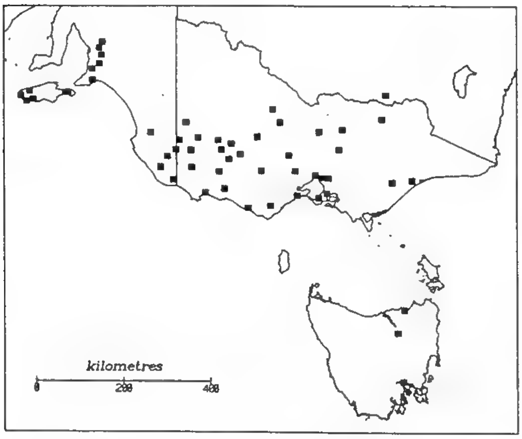
Aphelia gunnii J.D. Hook., Fl. Tasman 2: 75, t.138C (1858). Nom. illeg., as stated by Hooker to be a substitute name for *A. gracilis*.

Type: "(Gunn, 1499.) Wet places:Formosa, Gunn.-(Fl. Nov.)" [Tasmania], ex herb *R.C. Gunn* (holo.: K n.v.).

Tufted annual herb 2–4 cm high, remaining light green at flowering. *Leaves* obscurely distichous, 1-veined, glabrous; sheath subhyaline, 2–3 mm long, passing into a linear, lax flattened filiform lamina 1–2.3 cm long, c. 0.2 mm wide; apex acute, emucronate. *Cataphyll* usually absent, rarely 1–3 mm long, acute. *Scape* straight, 1.5–3.5 cm long, glabrous. *Spike* oblique, asymmetric, lanceolate-oblong, 2.5–5 mm long, 1.5–2.5 mm wide; rachis accrescent. *Primary bract* solitary, erect, ovate, acuminate, 3–4 mm long, glabrous, enclosing 1–2 male florets and often 1 female floret; back rounded, smooth; margins hyaline, entire, not reaching apex. *Distal bracts* 4–8, ovate-cymbiform, obtuse, 0.8–1.6 mm

long, each enclosing 1 female floret; backs rounded, smooth, pilose; margins broad, hyaline to the apex, ciliolate, becoming incurved in fruit. *Stamens* each subtended by an ovate, acute secondary bract 1.5–2 mm long; filament 1.5–2 mm long; anther elliptic, 0.6–0.7 mm long. *Ovary* c. 0.8 mm long; style 0.7–1 mm long; secondary bract absent. *Seed* 0.7–0.9 mm long; testa pale brown. (Fig. 1D, G; 2D)

Distribution (Map 3)



Map 3. Distribution of *Aphelia gracilis*

South Australia: southern Eyre Peninsula, Kangaroo Island, southern Mt Lofty and the South-eastern region. New South Wales: very localised in the Southern Western Slopes region. Victoria: widespread in the western district to about 36°S, extending to the central coast and the Murray Valley. Tasmania: localised near the northern and eastern coasts.

A record for Western Australia (Blackall & Grieve, 1954) is not confirmed by herbarium material and is apparently erroneous.

Ecology

Winter annual of seasonally flooded heavy soils in the 500–1000 mm annual rainfall zone, e.g. on clay pans and pool margins, where often associated with *Centrolepis glabra*. Flowers October, November.

Selected specimens examined (total 82)

SOUTH AUSTRALIA: Mary Seymour Conservation Park, 13.x.1982, *Donner 9310* (AD); above Waterfall, Belair, 27.xi.1960, *Eichler 17077* (AD); Stewarts Range, 17.xi.1962, *Hunt 1403* (AD); Lenswood Research Centre, 8.xi.1979, *Spooner 6768* (AD); Rocky River, 18.x.1968, *Wheeler 1221* (AD); Kelly Hill Reserve, 15.xi.1958, *Wilson 968* (AD).

VICTORIA: McDonald Park, Ararat, 16.xi.1966, *Beauglehole 21753* (MEL); Baddaginnie, 13.x.1942, *Black* (MEL); Mt Sturgeon, Grampians, 3.xi.1968, *Corrick 1237* (MEL); French Id, 30.xi.1980, *Gullan s.n.* (MEL); Oakleigh, 11.xi.1893, *Morrison* (AD, CANB); Jamieson road 3 miles from Eildon, 30.x.1960, *Muir 1615* (MEL).

TASMANIA: South Esk R., near Perth, 1848, *Stuart s.n.* (MEL).

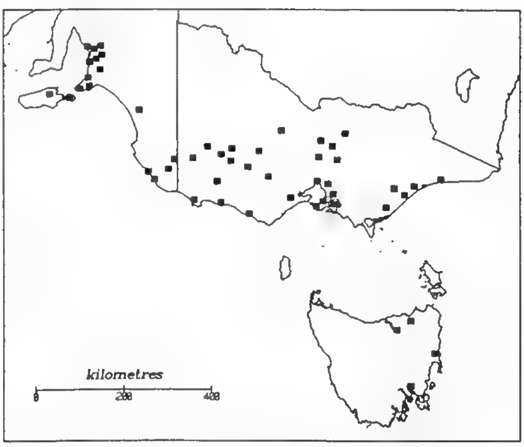
4. **Aphelia pumilio** F. Muell. ex Sonder, Linnaea 28: 226 (1856); J.D. Hook., Fl. Tasman. 2: 76 (1858); F. Muell., Fragm. Phyt. Aust. 5: 204 (1866); Benth., Fl. Austral. 7: 201 (1878); C. Moore, Handb. Fl. N.S.W. 441 (1893); Rodway, Tasm. Fl. 231 (1903); Ewart, Fl. Vict. 259 (1931); J. Black, Fl. S.Aust., 1: 177 (1943); J.H. Willis, Handb. Pl. Vict. 1: 277 (1962); Cooke, Fl. S. Aust. 4: 1824 (1986).

Type: Inter montem Gambir et sinum Rivolibay [between Mount Gambier and Rivoli Bay, S.A.], *F. Mueller* (Lecto. here chosen because it is the most typical and best preserved specimen: MEL 558048! pro parte, ex herb. Sonder); versus Rivoli Bay [S.A.], x.1848, *F. Mueller* (Syn.: MEL 558048! pro parte); In collibus arenosis virgultis Brighton versus [S.A.], x.1852, *F. Mueller* (Syn.: MEL 1501518!).

Brizula pumilio (F. Muell. ex Sonder) Hieron., Abh. Naturf. Ges. Halle 12: 206 (1873); F. Muell., Fragm. Phyt. Aust. 8: 237 (1874); J. Black, Fl. S.Aust. 1: 101 (1922).

Tufted annual herb 1–3 cm high, remaining light green at flowering. *Leaves* obscurely distichous, 1-veined, glabrous; sheath hyaline, 2–3 mm long, passing into a slightly recurved linear-subulate slightly keeled lamina 0.8–2 cm long, c. 0.5 mm wide; apex acute, mucronate. *Cataphyll* 1.5–3 mm long, acute, sometimes absent. *Scape* straight, 0.7–2.5 cm long, glabrous. *Spike* erect, symmetric, broad-ovate, 3–6 mm long, 3–4 mm wide, remaining dense; rachis not accrescent. *Primary bracts* two, unequal, glabrous, with entire margins and leaf-like apices, the first bract 4–10 mm long, the second 3–6 mm long, each enclosing 1–3 male florets. *Distal bracts* 4–9, ovate, acuminate, 1.5–2.8 mm long, each enclosing 1 female floret; backs keeled with a single median row of 1–3-celled hairs; margins broad, subhyaline, not extending to bract apex, ciliolate near the base, imbricate in flower, spreading in fruit. *Stamens* each subtended by a lanceolate-elliptic, acute secondary bract 1–1.7 mm long; filament c. 2 mm long; anther ovoid, 0.6–0.7 mm long. *Ovary* c. 0.9 mm long; style 1–1.4 mm long; secondary bract ovate, 2 mm long. *Seed* 0.7–0.9 mm long; testa dark brown. (Fig. 1F, K; 2F)

Distribution (Map 4)



Map 4. Distribution of *Aphelia pumilio*

South Australia: Southern Mt Lofty, eastern Kangaroo Island and South-eastern regions. Victoria: widespread in the western district to about 37°S, extending to the Gippsland coast and the Murray Valley. Tasmania: close to the northern and eastern coasts.

This species was listed by Moore (1893) and Maiden & Betche (1916) for New South Wales but this record is not confirmed by herbarium material.

Ecology

Winter annual of moist ground in heath, scrub and woodland in the 450–900 mm annual rainfall zone, often growing with *Centrolepis* spp. Flowers September to November.

Notes

Close to the Western Australian *A. brizula*, the two species forming a vicarious pair in south-western and south-eastern Australia respectively.

Selected specimens examined (total 85)

SOUTH AUSTRALIA: Mt Barker near summit, 1.x.1958, *Eichler 15010* (AD); Comaum, 28.x.1962, *Hunt 1310* (AD); Penola Forest near Nangwarry, 31.x.1964, *Hunt 2210* (AD); Parndana Reserve, *Jackson 650* (AD); National Park, Belair, 2.xi.1958, *Schodde 1020* (AD); Fairview Park, 10.x.1968, *Smith 2184* (AD); Torrens Gorge, 6.xi.1968, *Spooner 296* (AD).

VICTORIA: Mount Arapiles, 22.ix.1968, *Beauglehole 28644A* (MEL); Grampians, 37°9'30"S 146°16'E, 22.x.1978, *Corrick 6135* (MEL); 1.5 km north of Tallarook, 12.x.1978, *Muir 6182* (MEL); South Belgrave, 25.xi.1980, *Muir 6530* (MEL); Whittlesea, 17.x.1901, *St.John* (MEL); Hawkesdale, xi.1903, *Williamson* (MEL); Quail Island, Westernport Bay, 23.xi.1952, *Willis* (MEL).

TASMANIA: Tasmania, s.dat., *Archer 44* (NSW); near Launceston, 12.x.1887, *n.coll.* (MEL).

5. **Aphelia brizula** F. Muell., Fragm. Phyt. Aust. 5: 203 (1866); Benth., Fl. Austral. 7: 202 (1878); Rye in Marchant et al., Fl. Perth Reg. 2: 294 (1987).

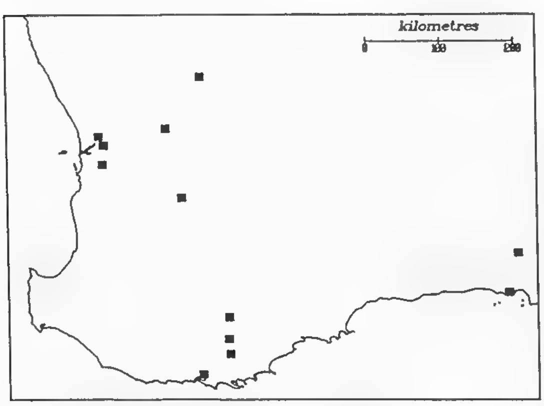
Type: ad flumen Cygnorum [W.A.], *J. Drummond 119* (holo.: MEL 1501519!).

Brizula muelleri Hieron., Abh. Naturf. Ges. Halle 12: 207 (1873), *pro syn. ut mülleri*; F. Muell., Fragm. Phyt. Aust. 8: 237 (1874); Diels & Pritzel, Bot. Jahrb. Syst. 35: 95 (1904); Blackall & Grieve, West. Aust. Wildfl. 1: 59 (1954); nom. illeg., based on *A. brizula* F. Muell.

Aphelia drummondii auct. non (Hieron.)Benth.: Baillon, *Hist. Pl.* 12: 129, figs. 213–217 (1892); Hamann, Ber. Deutsch. Bot. Ges. 75: 167 (1962).

Densely tufted annual herb 1–6 cm high, remaining light green at flowering. *Leaves* obscurely distichous, 1-veined, glabrous; sheath subhyaline, 3–6 mm long, passing into a slightly recurved linear-subulate slightly keeled lamina 5–20 mm long, c. 0.5 mm wide; apex subacute, mucronate. *Cataphyll* 2–4 mm long, acute, rarely absent. *Scape* straight, 0.3–5.5 cm long, glabrous. *Spike* erect, symmetric, broad-ovate, 3–7 mm long, 4–6 mm wide, remaining dense; rachis not accrescent. *Primary bracts* two, unequal, glabrous, the first bract with an ovate base 3–5 mm long, entire, usually produced into a leaf-like apex to 4 mm long, the second broad-ovate, apiculate, 3–4 mm long with a ciliolate margin, each enclosing 2–3 male florets. *Distal bracts* 4–14, broad-ovate, apiculate, 2–3.5 mm long, each enclosing 1 female floret; backs keeled, with a single median row of 1–2-celled hairs; margins broad, membranous, ciliolate near the base, imbricate in flower, spreading in fruit. *Stamen* subtended by a narrow-elliptic, acute, secondary bract 2–3 mm long; filament 2.5–3.5 mm long; anther elliptic, 0.7–1 mm long. *Ovary* c. 0.9 mm long; style 1.5–2 mm long; secondary bract broad-ovate, 2–3 mm long. *Seed* 1–1.1 mm long; testa dark brown. (Fig. 1A, L; 2A)

Distribution (Map 5)



Map 5. Distribution of *Aphelia brizula*.

Western Australia: Widespread from Perth to Cape Arid in the Darling, Eyre, Avon and Roe botanical districts between the 300 and 800 mm annual isohyets.

Ecology

Winter annual of moist open ground in woodland, also occurring in lithoseral moss beds on granite. Flowers August to October.

Selected specimens examined (total 43)

WESTERN AUSTRALIA: Darlington, ix.1902, *Andrews* (PERTH); N slopes Mt Angwin, 13.ix.1977, *Barker 2361* (AD); Mungliginup Creek, 33°51'S 122°40'E, 29.ix.1986, *Chinnock 7438* (AD); Middleton, 6.ix.1978, *Cranfield* (PERTH); Wittenoom Hills, 4.x.1968, *Donner 2892* (AD); Yorkrakine Rock, N of Tammin, 12.ix.1967, *George 9196* (PERTH); Bakers Hill Research Station, 26.ix.1962, *Goodall 812* (PERTH); summit of Mt Burdett, 4.x.1968, *Jackson 1331* (AD); 18 km SE Ongerup, 12.ix.1974, *Newbey 4365* (PERTH); Tutanning Reserve, 8.x.1964, *Royce 8191* (PERTH); Porongorup Ranges National Park, 6.x.1978, *Spencer 1* (MEL); c. 30 km N of Katanning, 20.ix.1964, *Wilson 3383* (AD); Albany Hwy 27 km SE Williams, 7.ix.1967, *Wilson 6203* (PERTH); Mt William near Wagerup, 5.ix.1979, *Van der Moezel 13* (PERTH).

6. **Aphelia drummondii** (Hieron.) Benth., Fl. Austral. 7: 201 (1878); Rye in Marchant et al., Fl. Perth Reg. 2: 294 (1987).

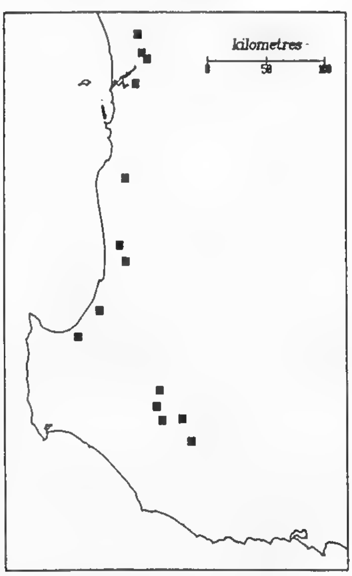
Type: Nova Hollandia inter occasum solis et meridiem spectante [W.A.], *J. Drummond* (holo.: B n.v.; iso.: MEL 1513971!). Both of these sheets bear Drummond's number 933 although this was not cited by Hieronymus. The holotype was originally cited as located at the Vienna Herbarium (W) but was later removed to Berlin-Dahlem; it bears the annotation

"Hb Hieronymus" (Leuenberger 1982, pers. comm.). Other probable isotypes are MEL 1513972 and MEL 1513973, both from Drummond's first collection but lacking numbers.

Brizula drummondii Hieron., Abh. Naturf. Ges. Halle 12: 206 (1873); Diels & Pritzel, Bot. Jahrb. Syst. 35: 95 (1904); Blackall & Grieve, West. Aust. Wildfl. 1: 59 (1954).

Tufted annual herb 2.5–8 cm high, remaining light green at flowering. *Leaves* obscurely distichous, 1-veined, glabrous; sheath subhyaline, 2.5–5 mm long, passing into a linear, lax flattened lamina 1–4 cm long, c. 0.25 mm wide; apex acute, emucronate. *Cataphyll* 2–4 mm long, acute, rarely absent. Scape straight, 2–7.5 cm long, glabrous. *Spike* oblique, asymmetric, broad-ovate, 3–7 mm long, 2–4.5 mm wide, remaining dense; rachis not accrescent. *Primary bract* solitary, erect, broad-ovate, acuminate, 2.5–3.6 mm long, glabrous, enclosing 3–8 male florets; back rounded, smooth; margins broad, membranous, entire. *Distal bracts* 6–15, broad-ovate, apiculate, 1.2–2.2 mm long, each enclosing 1 female floret; backs keeled, with 3 rows of inflated tooth-like hair bases in the central third of their length, the median row erect, the lateral rows deflexed; margins broad, membranous, finely erose, spreading in fruit. *Stamens* each subtended by an elliptic, acute, secondary bract 2–3 mm long; filament 3–5 mm long; anther elliptic, 1.2–1.5 mm long. *Ovary* c. 0.8 mm long; style c. 1 mm long; secondary bract broad-ovate, 0.8–2 mm long. *Seed* c. 0.8 mm long; testa pale brown. (Fig. 1C, H; 2C)

Distribution (Map 6)



Map 6. Distribution of *Aphelia drummondii*

Western Australia: Restricted to the Darling botanical district on the coastal plain between Ellen Brook and the Vasse River and on the Darling Plateau between Yornup and Lake Muir.

Ecology

Winter annual of seasonally flooded heavy soils, e.g. clay pans and pool margins, in the 500–1000 mm annual rainfall zone. It occupies wetter sites than *A. brizula* and is often associated with *Centrolepis glabra*. Flowers September to November.

Notes

A. drummondii is apparently closest to *A. brizula* but shows some convergence with *A. gracilis* in its foliage and single primary bract.

Selected specimens examined (total 22)

WESTERN AUSTRALIA: Midland Junction, 17.x.1902, *Andrews* (PERTH); Ellen Brook Sanctuary, 28.xii.1971, *Burbidge 7932* (CANB); Perup River E of Manjimup, x.1948, *Butler s.n.* (PERTH); Pinjarra, 27.ix.1897, *Helms* (PERTH); Cannington, 2.i.1899, *Helms* (PERTH); Ellen Brook Tortoise Reserve, 19.x.1978, *Keighery 1842* (PERTH); Brixton road, Kenwick, 21.x.1981, *Keighery 4175* (PERTH); Manjimup road 20 km S of Bridgetown, 20.xi.1981, *Keighery 4289* (PERTH); Cannington, 6.xi.1907, *Morrison* (PERTH); swamps near Tone River, *Oldfield 577* (MEL); Vasse River, *Oldfield s.n.* (MEL 577564); Yornup, 29.ix.1948, *Royce 2739* (PERTH); Elgin, 17.ix.1953, *Royce 4353* (PERTH); Benger, N of Bunbury, 11.x.1954, *Royce 4873* (PERTH).

Excluded species

Aphelia monogyna (J.D.Hook.)Hieron., Abh. Naturf. Ges. Halle 12: 208 (1873). This is a perennial with a capitular inflorescence containing reduced pseudanthia between two primary bracts, and is now placed in *Centrolepis* as *C. monogyna* (J.D.Hook.) Benth. (Cooke, 1992).

Acknowledgments

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Thanks are also due to the Directors or Curators of BM, CANB, HO, MEL, MELU, NSW, and PERTH herbaria for the loan of specimens. Dr. B. Leuenberger kindly checked Hieronymus' types at Berlin-Dahlem.

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Names

New names and combinations are in **bold**. Synonyms, misapplied, misspelt, illegitimate or invalid names are in *italics*.

Page numbers

Page numbers in **bold** refer to the main taxonomic treatment. Page numbers asterisked (*) refer to figures and maps.

JOURNAL of the ADELAIDE BOTANIC GARDENS

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Papers will be accepted in the following categories:

(a) Plant systematics (Australian and horticultural groups); (b) Descriptive plant morphology, anatomy and ecology; (c) Obituaries, biography and history; (d) Bibliographic studies, book reviews; (e) Botanical illustrations; (f) Noteworthy horticultural contributions. Preference will be given to unpublished material of suitable standard not intended for publication elsewhere.

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Bentham, G. (1868). "Flora Australiensis", Vol. 4. (L. Reeve: London).

Baker, J.G. (1898). Liliaceae. In Thiselton-Dyer, W. T. (ed.). "Flora of Tropical Africa", Vol. 7. (L. Reeve: Ashford).

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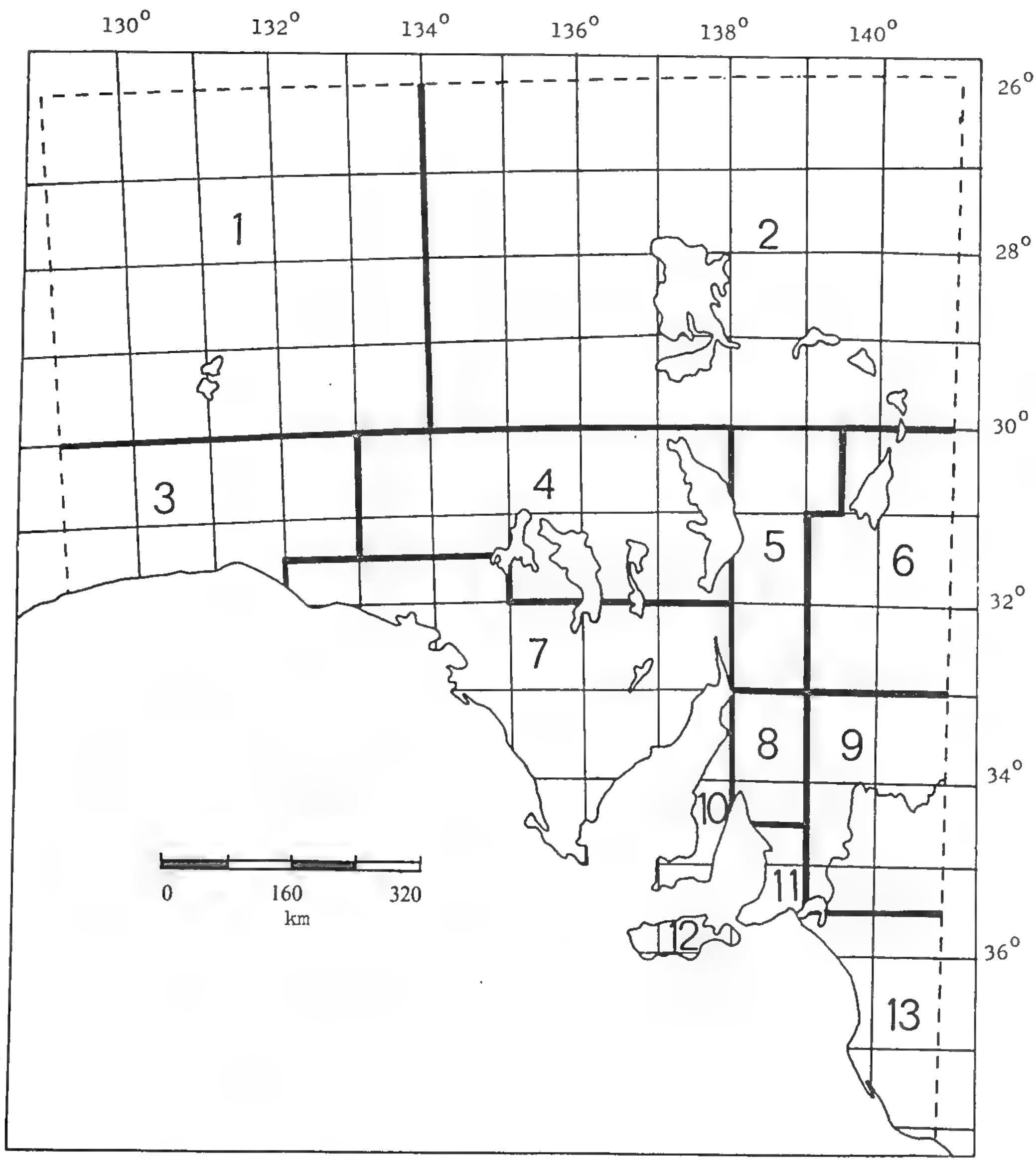

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A TAXONOMIC REVIEW OF *LANTANA CAMARA* L. AND *L. MONTEVIDENSIS* (SPRENG.)BRIQ. (VERBENACEAE)[1] IN AUSTRALIA

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Abstract

The taxonomy of the two species of *Lantana* in Australia — *L. camara* and *L. montevidensis* is reviewed. Affinities and distribution are considered for the genus and for each species. A key to the species is provided and a detailed description of each species is supplemented by a habit sketch of a flowering branch and analytical drawings of the flowers and map of distribution.

Taxonomic history of the genus

The genus *Lantana* as described by Linnaeus (1753) contained seven species: *L. trifolia, L. annua, L. camara, L. aculeata, L. bullata, L. corymbosa* and *L. africana*. The syntypes of the first six came from tropical America, and the last one *L. africana* from Ethiopia. The genus was placed with *Lippia* among other genera of the present Verbenaceae in "Didynamia Angiospermia", where it was retained by Reichard (1778), Loureiro (1790), Gmelin (1792), Schreber (1791), Persoon (1797), Willdenow (1800), Swartz (1800), Ventenat (1803), Nuttall (1818), Sprengel (1825), Link & Otto (1826), Roxburgh (1832) and Dietrich (1842). Adanson (1763) placed the genus in section II of Verbenae, Gleditsch (1764) in Petalostemonum, Rüling (1774) in Asperifoliae, Scopoli (1777) in Personatae, Gaertner (1788) in Centuria Quarta, Jussieu (1789) in Vitices, Necker (1790) in Plasyrgophytorum, Giseke (1792) and Batsch (1802) in Personatar, Moench (1794) in Petalostemon, Ventenat (1799) in Pyrenaceae, Link & Otto (1826) in Viticeae, and Reichenbach (1828) under the tribe Verbeneae in the Labiatae.

In 1805, Jaume Saint-Hilaire proposed the family Verbenaceae for *Lantana* and other related genera. The family Verbenaceae was accepted and the genus included in it by de Jussieu (1806), Kunth (1818), Bentham (1839, 1870, 1876), Endlichler (1838), Lindley (1847), Schauer (1847), Miquel (1858), Bailey (1883, 1901, 1906, 1913), Briquet (1895), Lam (1919) and most other botanists. Within this family, Jaume Saint-Hilaire distinguished the Premier Section with flowers opposite on a branched corymb, the Deuxieme Section (including *Lantana*) with flowers arranged in alternate spikes, and the Troisieme Section with genera having some affinity with the Verbenaceae.

In 1829, Dumortier divided the family Verbenaceae into two tribes, Verbeneae and Viticeae, with *Lantana* in the tribe Verbeneae. This tribe was accepted for the genus by Bartling (1830), Spach (1838), Bentham (1839, 1870), Schauer (1847), Miquel (1858), Grisebach (1864), Asa Gray (1886), Durand (1888), Bailey (1883, 1901, 1913), Fletcher (1938), Lemée (1943) and others. Endlicher (1838) divided the family Verbenaceae into three tribes: Lippieae with fruit drupaceous but splitting at maturity, Lantaneae (including *Lantana*) with fruit drupaceous but indehiscent, and Aegiphileae with fruit a berry. The tribe Lantanae was accepted for the genus by Meisner (1840), Endlicher (1841), Dietrich (1842), Walpers (1845, 1847) and Bocquillon (1863). Schauer (1847) re-classified the Verbenaceae into the tribes Verbeneae, Viteae and Avicennieae, and subdivided the tribe

[1]The present treatment of the genus *Lantana* is the fifteenth in the series of taxonomic revisions in the family Verbenaceae in Australia. (See Munir, 1982, 1984a, 1984b, 1985, 1987a, 1987b, 1989, 1990a, 1990b, 1991, 1992, 1993a, 1993b, 1995.)

Verbeneae into the seven subtribes Spielmannieae, Monochileae, Casselieae, Verbeneae, Lantaneae (including *Lantana*), Duranteae and Petreeae. The genus *Lantana* was divided by Schauer (1847) into three sections: *Sarcolippia, Camara* and *Callioreas*, with the Australian species *L. camara* in *Camara* and *L. montevidensis* in *Callioreas.*

Bentham (1876) proposed a new classification for the family Verbenaceae by dividing it into eight tribes: Phrymeae, Stilbeae, Chloantheae, Verbeneae, Viticeae, Caryopterideae, Symphoremeae and Avicennieae, with *Lantana* in the tribe Verbeneae. In 1895, Briquet re-classified the Verbenaceae and upgraded the tribe Verbeneae to the subfamily Verbenoideae. The latter consisted of six tribes: Euverbeneae, Lantaneae (including *Lantana*), Priveae, Monochileae, Petraeeae and Citharexyleae. This classification was adopted by Dalla Torre & Harms (1904), Lam (1919), Junell (1934), Moldenke (1959, 1971), Melchior (1964), López-Palacios (1977), Verdcourt (1992), Raj (1983) and Yamazaki (1995). In the same treatment, Briquet (1895) subdivided the genus *Lantana* into four sections: *Callioreas, Camara, Sarcolippia* and *Riedelia.* In this subdivision, the Australian species of the genus came under sections *Callioreas* (*L. montividensis*) and *Camara* (*L. camara*). The majority of botanists, however, have not divided the genus into sections, but have retained it within the Verbenaceae without reference to any subfamily or a tribe. In the present revision, Briquet's (1895) classification of the Verbenaceae is followed in retaining *Lantana* within the tribe Lantaneae. The subgeneric sections proposed for the genus may be useful, but not used here because there are only two species involved in this treatment.

Australian history of the genus

In view of Swarbrick's (1986) most comprehensive history of the genus *Lantana* in Australia, there is little need to go into detail here. Nevertheless, it seems desirable to make a very brief mention of its introduction into Australia and of the very early Australian collections from naturalised populations. Several *Lantana* taxa have been introduced to Australia, of which, only *L. camara* and *L. montevidensis* have become naturalised. The earliest known published reference to *Lantana* in Australia is that of J. Bailey (1841) who introduced *L. mista* (now a synonym of *L. camara*) to one of the early sites for the Adelaide Botanic Garden. In 1843, Macarthur cultivated it at Camden Park near Sydney (Swarbrick 1986, Parsons & Cuthbertson 1992), and later Shepherd (1851) advertised three types of *Lantana* for sale at his Darling Nursery in Sydney. Since then, numerous introductions have been made by nurseries (Parsons & Cuthbertson 1992). According to Swarbrick (1986), "seven forms [species?] of *Lantana* were grown in Australia by 1859". Parsons & Cuthbertson (1992) claim that *L. camara* "was naturalised along the Brisbane River, Queensland, by the late 1850s". On the contrary, Swarbrick (1986) states that "*Lantana* was not definitely recorded as a garden escape in the Brisbane area until F.M. Bailey & Tennison-Woods (1879) noted that it was flowering all summer along the river".

Swarbrick (1986) also reports that "the earliest herbarium specimen is in the National Herbarium in Melbourne and was apparently collected on the Brisbane River in August 1861, but the writing is unclear and the [herbarium] sheet lacks the collector's name. There is also a specimen with small thorns collected by B.T. Lowe in 1862 and labelled 'Near Sydney, common, an introduced species' in the herbarium of the Royal Botanic Gardens at Kew in England". Swarbrick noted that in 1986 "there are several undated collections of *Lantana* in the National Herbarium in Melbourne from this period", but the present author has not found any of these sheets. Nevertheless, *L. camara* was collected by H. Beckler in 1869 from Hasting River which is now preserved in Herb. MEL. It was described by Bentham (1870) as "naturalised on the Hasting and Clarence Rivers" in New South Wales. In 1879, F.M. Bailey described *L. camara* as "a most troublesome weed" in Queensland. He also reported it as "equally abundant all-round Port Jackson" in New South Wales. Since then, naturalised *Lantana* has been recorded by F.M. Bailey (1883, 1888, 1889, 1890, 1901, 1906, 1913), C. Moore (1884), Lauterer (1904), Dixon (1906) and C.T. White (1927,

1929). In early Australian records *L. camara* was mostly recorded as *L. mista* L., *L. crocea* Jacq. or *L. tiliaefolia* Cham., and *L. montevidensis* (Spreng.)Briq. as *L. sellowiana* Link & Otto.

Chromosome numbers

Cytological studies by Henderson (1969) "showed the genus *Lantana* to be dibasic with base numbers 11 & 12 and that there are polyploid series based on both these numbers", and this is supported by other botanists. Moldenke (1983) has given the base (i.e. haploid) numbers 8 and 11, though no one else is known to have recorded 8 as a basic number. Sinha and Sharma (1984) mentioned several cytological works on *Lantana*, in all of which the basic chromosome number was found to be 11 and 12. They also pointed out the existence in the genus of polyploid series based on these two numbers.

Chromosome counts of twenty *Lantana* species have been located, of which the majority are for *L. camara*. Excepting Henderson (1969), these counts are based on material from outside Australia. The highest number (2n = 72) was reported by Natarajan & Ahuja (1957) & Arora (1960), and (2n = 66) by Bir & Chatha (1983). The lowest number (2n = 22) was recorded by Tandon & Chandi (1955), Natarajan & Ahuja (1957), Lewis (1961c), Malik & Ahmad (1963), Bir & Chatha (1983), Sanders (1987, 1987a), Sandhu & Mann (1988) and Sen & Sahni (1955).

L. camara and *L. montevidensis* have basic chromosome numbers of 11 and 12 respectively. Chatha & Bir (1988), however, recorded a basic chromosome number of 11 for *L. montevidensis*. Both Australian species are reported to be polyploid in both cultivated and wild forms. According to Spies & Stirton (1982), "*L. camara* is today recognised as a polyploid aggregate species with a basic chromosome number of x = 11 and having diploid, triploid, tetraploid, pentaploid and hexaploid representatives (Schnack & Coves, 1947; Tjio, 1948; Singh, 1951; Sen & Sahni, 1955; Tandon & Bali, 1955; Tandon & Chandi, 1955; Natarajan & Ahuja, 1957; Henderson, 1969; Spies & Stirton, 1982)". In support of this, Spies (1984) re-affirmed that "the cytological data showed that chromosome numbers of 2n = 22, 33, 44, 55 and 66 are found in the *Lantana camara* complex". According to Henderson (1969), two forms of *L. montevidensis* are known to occur in Australia. The garden form which does not produce fruit here is triploid (2n = 36) and the naturalised form is tetraploid (2n = 48). Overall, the haploid (i.e. basic) numbers 11 and 12 seem to be generally consistent in the genus.

LANTANA L.

Lantana L., Sp. Pl. edn 1, 2 (1753) 626; Gen. Pl. edn 5 (1754) 275;
Gaertn., Fruct. Sem. Pl. 1 (1788) 267; Juss., Gen. Pl. (1789) 109; Lour., Fl. Cochinch. 2 (1790) 376; Willd., Sp. Pl. 3 (1800) 315, no. 1165; J. St.-Hil., Expos. Fam. Nat. 1 (1805) 250; Juss., Ann. Mus. Natl. Hist. Nat. 7 (1806) 75; Kunth in Humb., Bonpl. & Kunth, Nov. Gen. & Sp. Pl. 2 (1818) 258; Nutt., Gen. N. Amer. Pl. 2 (1818) 41; Kunth in Humb., Bonpl. & Kunth, Synop. Pl. 2 (1823) 49; Spreng., Syst. Veg. 2 (1825) 761, no. 2126; Dumort., Anal. Fam. Pl. (1829) 22; Bartl., Ord. Nat. Pl. (1830) 180; Roxb., Fl. Ind. 3 (1832) 89; Endl., Gen. Pl. 1 (1838) 635, no. 3695; Schauer in A. DC., Prod. Syst. Nat. 11 (1847) 594; Walp., Repert. Bot. Syst. 6 (1847) 689; Miq., Fl. Ind. Bat. 2 (1858) 904; Bocq., Rev. Groupe Verbenac. (1863) 88, 151; Benth., Fl. Aust. 5 (1870) 34; Benth. in Benth. & Hook.f., Gen. Pl. 2 (1876) 1142; F.M. Bailey, Synop. Qld Fl. (1883) 375; C.B. Clarke in Hook.f., Fl. Brit. Ind. 4 (1885) 562; Briq. in Engl. & Prantl, Nat. Pflanzenf. 4, 3a (1895) 150; F.M. Bailey, Qld Fl. 4 (1901) 1170; F.M. Bailey, Weeds & Suspect. Poison Pl. Qld (1906) 140; King & Gamble, J. As. Soc. Bengal 74, Part 2 (1908) 792; H.J. Lam, Verbenac. Malay, Archip. (1919) 10; Ridl., Fl. Mal. Penin. 2 (1923) 611; Moldenke, Publ. Carnegie Inst. Wash. No. 522 (1940) 153; Moldenke in Pulle (ed.), Fl. Suriname 2, Part 2 (1940) 262; Moldenke, Résumé Verbenac. etc. (1959) 248, 250, 320, 343, 353, 393, 405, 458; J.F. Macbr., Field Mus. Nat. Hist. Bot. Ser. 13, Part 5, No. 2 (1960) 632; N.T. Burb., Dict. Aust. Pl. Gen. (1963) 169; Cooke, Fl. Pres. Bomb. 2, repr. edn (1967) 498; R.A. Howard, Arnoldia 29, No. 11 (1969) 73–78; D.N. Gibson in Standl. & L.O. Williams, Fl. Guatemala, Fieldiana 2, Part 9, nos 1 & 2 (1970) 201; Moldenke, Fifth Summary Verbenac. etc. 1 & 2 (1971) 40, 424, 533, 572, 618, 639, 735, 753, 883; Moldenke, Ann. Missouri Bot. Gard. 60 (1973) 47; López-Pal., Fl. Venezuela Verbenac. (1977) 327; Moldenke in Dassan. & Fosberg, Fl. Ceylon 4 (1983) 212; Rye in N.G. Marchant *et al.*, Fl. Perth Reg. 1 (1987) 550; Jans.-Jac. in Görts, Fl. Guianas Ser. A. Phan. Fase. 4. Verbenaceae (1988) 42; R.W. Sanders in R.A. Howard, Fl. Lesser Antilles Dicot. Part 3 (1989) 226; W.L. Wagner, Fl. Pl.

Hawaii 2 (1990) 1319; A.C. Sm., Fl. Viti. 5 (1991) 171; Verdc. in Polhill (ed.), Fl. Trop. E. Afr. Verbenaceae (1992) 37.

Lectotype: *L. camara* L., designated by N.L. Britton, Fl. Bermuda (1918) 314. [A.S. Hitchcock & M.L. Green (1947) selected *L. trifolia* L. which was accepted by Moldenke (1983)].

Camara Plum. ex L., Gen. Pl. edn 5 (1754) 275, *nom. nud.* in syn. – *fide* Moldenke (1973, 1983), López-Pal. (1977).

Kamara Adans., Fam. Pl. 2 (1763) 12, *nom. nud.* – *fide* López-Pal. (1977), Moldenke (1983).

Myrobatindum Vaill. ex L., Gen. Pl. edn 5 (1754) 275, *nom. nud.*

Riedelia Cham., Linnaea 7 (1832) 240 [not Trin. ex Kunth (1833), nor Meisn. (1863), nor Oliver (1883)] – *fide* Moldenke (1940, 1973, 1983), López-Pal. (1977).

Type: *R. lippioides* Cham.

Tamonopsis Griseb., Abh. Königl. Ges. Wiss. Göttingen 19 (1874) 246; Kuntze, Rev. Gen. Pl. 2 (1891) 504 – *fide* Moldenke (1940, 1973, 1983), López-Pal. (1977).

Type: *T. spicata* Griseb.

Erect, scandent or prostrate herbs or shrubs. *Stems* branched, usually more or less scabrous and hirsute, sometimes armed with thorns or prickles. *Leaves* simple, decussate-opposite or ternate, often bullate or rugose, usually dentate or serrate, mostly aromatic, exstipulate, petiolate or subsessile. *Inflorescences* axillary, pedunculate, of contracted heads or dense cylindric spikes. *Flowers* sessile, in axils of bracts, bisexual, hypogynous. *Calyces* small, persistent, gamosepalous, tubular, membranous, truncate or sinuate-dentate. *Corollas* gamopetalous, hypocrateriform, red, yellow, purple, blue, mauve or white, sometimes bicoloured with throat yellow to orange, often changing colour after fertilisation; tube narrow-cylindrical or somewhat ampliate above the middle, sometimes curved; limbs spreading, regular or obscurely 2-lipped, 4- or 5-lobed; lobes broadly obtuse or retuse at apex. *Stamens* 4, didynamous, included, inserted at or above the middle of the corolla tube; filaments very short; anthers dorsifixed, the cells parallel. *Ovaries* bicarpellary, syncarpous, but generally appearing 1-carpellate (see comments) due to only one carpel usually being developed, 2-locular with 1 basal erect ovule in each locule; style terminal, short, with thick oblique or sublateral stigma. *Fruits* drupe, the mesocarp fleshy when mature; endocarp hard, 2-locular or splitting into two 1-locular pyrenes. *Seeds* without endosperm.

Number of species: World ± 160 species and several infraspecific taxa; Australia 2 naturalised species introduced from tropical America.

Derivation of name

Most authors agree that the name *Lantana* is an ancient name of the *Viburnum* L., which it resembles a little in foliage and inflorescence. Wagner et al. (1990) state that "*Lantana* is the Latin name for the genus *Viburnum* L., which was transferred to *Lantana* by Linnaeus possibly based on the similarity of the inflorescences". According to Parsons & Cuthbertson (1992), "*Lantana* is from the Latin *lento*, to bend, and was an ancient name for the European wayfaring tree, *Viburnum lantana*, and is used here because of some similarities in foliage and floral structure".

Distribution

The genus *Lantana* is mostly native to subtropical and tropical America, but there are also a few taxa indigenous to tropical Asia and Africa. It was seemingly introduced to Europe as an ornamental from whence it was carried to various European colonies. It now occurs in about 47 countries (Parson & Cuthbertson, 1992) where several species are widely cultivated under hundreds of cultivar names (Howard, 1969). A few species, like *L. camara*, are aggressive weeds. In Australia, the genus is represented by two naturalised

species, both occurring chiefly in the coastal areas of Queensland and New South Wales. Here it occurs from the tip of Cape York Peninsula southwards along the coast to Narooma township in New South Wales. It has been recorded naturalised around Darwin in the Northern Territory in 1948, from near Perth, Western Australia in 1974 and around Adelaide, South Australia in 1904.

Comments

In *Lantana*, the ovary has been recorded as 1-carpellate by Moldenke (1939, 1940, 1956, 1971, 1973, 1983), Gibson (1970), López-Palacios (1977), Wagner et al. (1990) and a few others. According to Bentham (1870), however, "the ovary in this and the following genus [*Lippia*], as shown by Bocquillon, although containing only 2 cells corresponding to the half-cells of other genera, is yet bicarpellary, one half only of each carpel being developed". This view is supported by the above botanists in their description of the family Verbenaceae. They all agree that the gynoecium in this family is "composed of 2 (rarely 4 or 5) united carpels" of which one sometimes aborts resulting in a monocarpellary ovary. López-Palacios (1977) has cited *Lantana* as an example of this change.

In recent publications the recorded number of *Lantana* species ranges from 50 (Gibson 1970, Sanders 1989) to 160 (Wagner et al., 1990, A.C. Smith, 1991, Verdcourt, 1992, A.J. Scott, 1994). In "Flora of the Guianas", Jansen-Jacobs (1988) recorded the highest estimate of 240 species. She may have meant 240 specific and infraspecific taxa, as Moldenke (1956, 1973, 1983) who has not given the number of species has quoted 208 to 270 specific and subspecific entities. Macbride (1960) stated that the species in this genus are "apparently not stable and may be fewer than described, ... there are probably about half as many genetic species (or even fewer) than names". As mentioned above, Verdcourt (1992) recorded "about 150 species" in the genus but he also wrote that "the true number of taxa is probably much less". A taxonomic revision of the whole genus is needed to ascertain the actual number of taxa.

A number of species are widely cultivated and there are numerous named cultivars. Howard (1969) admits that "the genus *Lantana* is not an easy one to consider taxonomically". He published a checklist of about 650 cultivar names used in this genus. In his opinion, "the descriptive information available on the cultivars of *Lantana* is mostly brief and is frequently confusing. Selections of *Lantana* may have inflorescences of varying shapes – flat vs. curved or globular – yet this distinction is a matter of the age of the inflorescence. Colors are important in the choice of special varieties, yet individual flowers vary in color with age and maturity". A more or less similar view has been expressed by Sinha & Sharma (1984) who stated that "the colour of the flowers varies from species to species. It even differs in different populations of the same species. ... Changes in flower colour subsequent to anthesis also occur in the same spike". These remarks suggest that from a taxonomic point of view the shape of inflorescence and the colour of flowers in *Lantana* are not reliable characters.

According to Wagner *et al.* (1990) and Verdcourt (1992) "hybridization appears to be widespread in the genus". Spies (1984) observed that "hybridization results in the continuous variation of characters between the parental extremes, and the hybrids may even exceed the parents in some instances. This fact is responsible for the exceedingly difficult task of classifying a hybrid complex according to normal morphological taxonomic procedures". He also pointed out that "it is unpractical to depend on cytological data alone for the classification of plants".

In some parts of the world including eastern Australia, a few *Lantana* species including *L. camara* are aggressive weeds. According to Jex-Blake (1957), however, "there are some, and many garden hybrids too, that are good and safe, and do not seed themselves as does *L. camara*".

Most *Lantana* species are reported to be poisonous to live stock, but in Africa a few are used for the cure of various human diseases (Irvine, 1961).

Affinities

Lantana is closely related to *Lippia*, in that its inflorescence is spicate or subspicate during anthesis, elongating in fruit and its flowers sessile and each subtended by a sessile bract; its calyx being small, membranous and usually hidden by the subtending bract; its 4 perfect stamens; its anthers without appendages; its stigma oblique; its fruit composed of 2 mericarps, mostly splitting at maturity; and its mericarps 1-celled and 1-seeded. Nevertheless, *Lantana* may easily be distinguished by its stem and leaves being harshly pubescent; its calyx-rim almost truncate or sinuate-dentate, not 2-lipped nor distinctly toothed; its ovary 1-carpellate due to abortion of the second carpel; and its fruit drupaceous with a fleshy and juicy exocarp and hard endocarp. For more information on the affinities between *Lantana* and *Lippia* see Jansen-Jacobs (1988, p. 42) and Munir (1993a, p. 113 & 1993b, p. 133).

There are a few characters common to *Lantana* and *Duranta*. Both have oblique stigmas and drupaceous fruits, but *Duranta* differs in its leaves being non-scabrous; its inflorescence racemose, not of contracted heads or dense cylindrical spikes; its flowers usually pedicellate; its calyces 5-ribbed and toothed; and its ovaries composed of 4 bilocular carpels.

According to Sinha & Sharma (1984), "the genus [*Lantana*] is closely allied to some members of the families Acanthaceae and Labiatae [Lamiaceae] from which it may be distinguished by the two-celled ovary with one ovule in each cell and the character of the fruit (Rendle 1925). *Lantana* also differs in the characters of inflorescence and the terminal style from Acanthaceae and Labiatae. It establishes a link with the members of Boraginaceae and can be separated from the latter by the ascending ovule (Takhtajan 1969) and in the arrangement of leaves (Cronquist 1968)".

Key to Australian species of *Lantana*

1a. Outer bracts of inflorescence similar in size to inner, linear-lanceolate, often 1–2 mm wide, not conspicuously involucrate; erect shrub; stems and branches often armed with prickles or spines, usually not rooting at nodes; lamina to 120 × 80 mm .... 1. *L. camara*

b. Outer bracts of inflorescence much larger than inner, broadly ovate, often 5 mm wide, conspicuously involucrate; prostrate or decumbent woody herb or subshrub; stems and branches unarmed, usually rooting at nodes that touch the ground; lamina to 35 × 20 mm .... 2. *L. montevidensis*

1. Lantana camara L., Sp. Pl. edn 1, 2 (1753) 627, **var. camara**[2].

Willd., Sp. Pl. 3 (1800) 317;Spreng., Syst. Veg. 2 (1825) 762; Walp., Repert. Bot. Syst. 4 (1845) 61; Schauer in DC., Prod. 11 (1847) 598; Benth., Fl. Aust. 5 (1870) 34; F.M. Bailey & Ten.-Woods, Proc. Linn. Soc. N.S.W. 4 (1879) 29 & 174; F.M. Bailey, Synop. Qld Fl. (1883) 375; C.B. Clarke in Hook.f., Fl. Brit. Ind. 4 (1885) 562; F.M. Bailey, Qld Fl. 4 (1901) 1170; Lauterer, Proc. Roy. Soc. Qld 18 (1904) 59; F.M. Bailey, Weeds & Suspec. Poison. Pl. Qld (1906) 141, fig. 241; F.M. Bailey, Comp. Cat. Qld Pl. (1913) 382; Domin, Biblioth. Bot. 89 (1928) 551; C.T. White, Qld Agric. J. 31, Part 4 (1929) 294, t. 87 p.p.; C.A. Gardner, Enum. Pl. Aust. Occ. Part 3 (1931) 111; Moldenke, Lilloa 4 (1939) 288; Moldenke, Publ. Carnegie Inst. Wash. No. 522 (1940) 162; L.J. Webb, Bull. C.S.I.R. No. 232 (1948) 168; Moldenke, Résumé Verbenac. etc. (1959) 209, 458; J.F. Macbr., Field Mus. Nat. Hist. Bot. Ser. Vol. 13, Part 4 (1960) 634; N.C.W. Beadle et al., Handb. Vasc. Pl. Syd. Dist. & Blue Mt. (1963) 416; Meikle in Hutch. & Dalziel, Fl. W. Trop. Afr. 2nd edn, 2 (1963) 435; Backer & Bakh.f., Fl. Java 2 (1965) 597; R.A. Howard, Arnoldia 29 (1969) 75; D.N. Gibson in Standl. & L.O. Williams, Fl. Guatemala, Fieldiana: Bot. 24, Part 9 (1970) 202; Moldenke, Fifth Summary Verbenac. etc. 1 & 2 (1971) 347, 884; Chippend., Proc. Linn. Soc. N.S.W. 96, Part 4 (1972) 256; Moldenke, Ann. Missouri Bot. Gard. 60 (1973) 57; López-Pal., Fl. Venezuela, Verbenac. (1977) 351, fig. 83; Kleinschmidt & R.W. Johnson, Weeds Qld (1977) 33,

[2]Of the several named varieties of *L. camara* the present author has been able to examine the microfiche of the typical variety and var. *aculeata*. The type of the typical variety matches well with the Australian material of the species. In view of geographical limit of this review, no attempt was made to examine the types of other varieties. In the synonymy, the names not used in Australia or the neighbouring regions have been excluded.

186, 260; Moldenke, Sixth Summary Verbenac. etc. Phytologia Mem 2 (1980) 337, 553; N.C.W. Beadle, Fl. Syd. Reg. edn 3 (1982) 510; L.S. & D.A. Smith, Qld Bot. Bull. No. 1 (1982) 1–21; Spies & C.H. Stirt., Bothalia 14, No. 1 (1982) 101–111; Moldenke in Dassan & Fosberg, Fl. Ceylon 4 (1983) 220; Raj, Rev. Palaeobot. Palynol. 39 (1983) 349; D.J. Carr (ed.), Syd. Park. Artist Cook End. Voy. (1983) 61, t. 56; N.C.W. Beadle, Stud. Fl. NE N.S.W. Part 5 (1984) 850, fig. 373B; S. Sinha & A. Sharma, Feddes Repert. 95 (1984) 621–633; Spies, S. Afr. J. Bot. 3, no. 4 (1984) 231–250; Stanley in Stanley & E.M. Ross, Fl. S.E. Qld 2 (1986) 365; Rye in N.G. Marchant et al., Fl. Perth Reg. Part 1 (1987) 550; Jans.-Jac. in Görts, Fl. Guianas (1988) 43; R.A. Howard, Fl. Lesser Antilles, Dicot., Part 3 (1989) 227; W.L. Wagner et. al., Fl. Pl. Hawaii (1990) 1320; A.D. Chapm., Aust. Pl. Name Index K–P (1991) 1746; A.C. Sm., Fl. Viti. Nova. 5 (1991) 172; W.T. Parsons & Cuthbertson, Noxious Weeds Aust. (1992) 627–632; Verdc., Fl. Trop. E. Afr. Verbenac. (1992) 39; Lazarides & Hince, Econ. Pl. Aust. (1993) 144; Dowling & McKenzie, Poison Pl. (1993) 136; P.S. Green, Fl. Aust. 49 (1994) 313; A.J. Scott, Fl. Mascar. Verbenac. (1994) 9; Pedley in R.J.F. Hend. (ed.), Qld Vasc. Pl. (1994) 336.

Type: "Linnean Herbarium No. 783/4, probably collected from cultivated material in the University garden at Uppsala, Sweden" (LINN, microfiche!). Designated by H.N. Moldenke (1983). "Type locality: Brazil" – *fide* P'ei (1932). [*Note*: The typification of var. *camara* has neither been adequately discussed by previous authors nor investigated by the present author.]

L. aculeata L., Sp. Pl. edn 1, 2 (1753) 627; Curtis, Bot. Mag. 3 (1790) t. 96; Willd., Sp. Pl. 3 (1800) 320; King & Gamble, Mat. Fl. Malay. Penin., J. Asi. Soc. Beng. 75 (1909) 796; H.J. Lam, Verbenac. Malay. Archip. (1919) 12; H.J. Lam, Bull. Jard. Bot. Buitenzorg. Ser. III, 3 (1921) 4; Ridley, Fl. Malay. Penin. 2 (1923) 612.

Type: Linnean Herbarium No. 786/6, specimen grown at the University of Uppsala Botanic Garden (LINN, microfiche!). Designated by H.N. Moldenke (1983) under *L. camara* var. *aculeata*. [*Note*: The typification of var. *aculeata* has neither been adequately discussed by previous authors nor investigated by the present author.]

L. mista L., Syst. Nat. edn 12, 2 (1767) 417; Willd., Sp. Pl. 3 (1800) 315; Walp., Repert. Bot. Syst. 4 (1845) 60. – *fide* D.N. Gibson (1970).

Type: From a plant cultivated in the garden of L. Sherard at Eltham, England, collected about 1726 (OXF, n.v.) – *fide* Moldenke (1983).

L. flava Medik., Hist. & Commentat. Acad. Elect. Sci. Theod.-Palat. 3, Phys. (1775) 225 – *fide* W.L. Wagner et al. (1990).

Type: (n.v.). According to Stafleu & Cowan (1981), Medikus's herbarium and types are unknown.

L. sanguinea Medik., Hist. & Commentat. Acad. Elect. Sci. Theod.-Palat. 3, Phys. (1775) 229; Schauer in DC., Prod. 11 (1847) 600 – *fide* W.L. Wagner et al. (1990).

Type: (n.v.) According to Stafleu & Cowan (1981), Medikus's herbarium & types are unknown.

L. splendens Medik., Hist. & Commentat. Acad. Elect. Sci. Theod.-Palat. 3, Phys. (1775) 226 – *fide* Moldenke (1980).

Type: "*Dillenius s.n.*, from James Sherard's garden at Eltham, England (OXF)", n.v. – *fide* Moldenke (1983).

L. nivea Vent., Jard. Malmaison 1, Part 2 (1803) 8, t. 8; Spreng., Syst. Veg. 2 (1825) 761; Walp., Repert. Bot. Syst. 4 (1845) 59; Schauer in Mart., Fl. Brasil 9 (1851) 225 – *fide* W.L. Wagner et al. (1990).

Type: Rio de Janeiro, Brazil (G-DC., microfiche!).

L. crocea Jacq., Pl. Hort. Schoenbr. 4 (1804) 37, t. 473; F.M. Bailey, Qld Fl. 4 (1901) 1171; F.M. Bailey, Comp. Cat. Qld Pl. (1913) 382; C.T. White, Qld Agric. J. Ser. 2, 27 (1927) 481; A.D. Chapm., Aust. Pl. Name Index K–P (1991) 1747 – *fide* Urban (1911), R. Knuth (1927).

Type: "Crescit in Jamaica. Floret in Caldario Aprili & May" (W, n.v.).

L. antidotalis Schumach. & Thonn., Beskr. Guin. Pl. (1827) 276; Schauer in DC., Prod. 11 (1847) 598; Moldenke, Résumé Verbenac. etc. (1959) 133, 135, 136, 142, 147, 219, 458; Moldenke, Fifth Summary Verbenac. etc. 1 (1971) 210, 215, 216, 230, 244, 364 – *fide* Meikle (1963), Verdcourt (1992).

Type: *Thonning 125*, loc. incert., "Ghana [Guinea] (C, syn., P-JU, isosyn." n.v.) – *fide* Verdcourt (1992).

L. nivea Vent. var. *mutabilis* Hook., Curtis Bot. Mag. Vol. 58, N. Ser. Vol. 5 (1831) t. 3110 – *fide* W.L. Wagner et al. (1990).

Type: Plate 3110 in Curtis Bot. Mag. 58 (1831).

L. tiliaefolia Cham., Linnaea 7 (1832) 122; Schauer in DC., Prod. 11 (1847) 600; Moldenke, Fifth Summary Verbenac. etc. 1 & 2 (1971) 347, 889; Moldenke, Sixth Summary Verbenac. etc. Phytologia Mem. II (1980) 337,

557; S.W.L. Jacobs & J. Pickard, Pl. N.S.W. (1981) 209; N.C.W. Beadle, Student Fl. NE N.S.W., Part 5 (1984) 850; A.D. Chapm., Aust. Pl. Name Index K–P (1991) 1747 – *fide* D.N. Gibson (1970).

Type: *Sieber s.n. for J.C. Hoffmannsegg*, Bahia, Brazil, 1804 (B–W No. 11502, microfiche!).

L. hirsuta M. Martens & Galeotti, Bull. Acad. Roy. Sci. Bruxelles 11 (1844) 326; R. Knuth, Feddes Repert. Sp. Nov. Beih 43 (1927) 600 – *fide* D.N. Gibson (1970).

Type: *Henrico Galeotti no. 749*, loc. inc., Mexico, – (BR, n.v.).

L. viburnoides Blanco, Fl. Filipp. edn 2 (1845) 345 *nom. illeg.*, not *L. viburnoides* Vahl (1790) – *fide* H.J. Lam (1919), Merrill (1923), Moldenke (1983).

Type: According to E.D. Merrill (1905), "the types of all Blanco species have been destroyed".

L. hybrida Hort. ex Neub., Deutsch. Gart. Mag. 10 (1857) 98 – *fide* W.L. Wagner et al. (1990).

Type: Plate on p. 98 in the protologue, otherwise no specimen cited.

Camara aculeata (L.)Kuntze, Rev. Gen. Pl. 1 (1891) 503 – *fide* Domin (1928), Moldenke (1940, 1983), López-Pal. (1977).

Type: As for *L. aculeata* L.

C. aculeata (L.)Kuntze var. *normalis* Kuntze, Rev. Gen. Pl. 1 (1891) 503 – *fide* Moldenke (1939, 1940, 1973, 1983).

Type: As for *L. camara* L.

Lantana camara L. var. *crocea* (Jacq.)L.H. Bailey, Cycl. Amer. Hort. 2 (1900) 884; L.J. Webb, Bull. Council Sci. Industr. Res. No. 232 (1948) 169; A.D. Chapm., Aust. Pl. Name Index K–P (1991) 1746 – *fide* D.N. Gibson (1970).

Type: As for *L. crocea* Jacq.

L. camara L. var. *mista* (L.)L.H. Bailey, Cycl. Amer. Hort. 2 (1900) 884; Moldenke, Ann. Missouri Bot. Gard. 60 (1973) 58; López-Pal., Fl. Venezuela Verbenac. (1977) 358, fig. 85; Moldenke in Dassan & Fosberg, Fl. Ceyl. 4 (1983) 229; A.C. Smith, Fl. Viti. 5 (1991) 173 – *fide* D.N. Gibson (1970).

Type: As for *L. mista* L.

L. camara L. var. *mutabilis* (Hook.)L.H. Bailey, Cycl. Amer. Hort. E–M (1900) 884; H. St. John, Fl. Pl. Hawaii. Isls (1973) 290 – *fide* W.L. Wagner et al. (1990).

Type: As for *L. nivea* Vent. var. *mutabilis* Hook.

L. camara L. var. *nivea* (Vent.)L.H. Bailey, Cycl. Amer. Hort. 2, E–M (1900) 883; H. St. John, Fl. Pl. Hawaii. Isls (1973) 290 – *fide* W.L. Wagner et al. (1990).

Type: As for *L. nivea* Vent.

L. camara L. var. *sanguinea* (Medik.)L.H. Bailey, Cycl. Amer. Hort. 2, E–M (1900) 884; C.T. White, Qld Agric. J. Ser. 2, 31, Part 4 (1929) 294; H. St. John, Hawaii. Fl. Pl. (1973) 290; A.D. Chapm., Aust. Pl. Name Index K–P (1991) 1746; – *fide* W.L. Wagner et al. (1990).

Type: As for *L. sanguinea* Medik.

L. camara L. var. *aculeata* (L.)Moldenke, Torreya 34 (1934) 9; Parham, Pl. Fiji Isls (1964) 215; Parham, Pl. Samoa (1972) 54; H. St. John, Fl. Pl. Hawaii. Isls (1973) 290; Moldenke, Ann. Missouri Bot. Gard. Fl. Panama 60 (1973) 58; Lopéz-Pal., Fl. Venezuela, Verbenac. (1977) 356, fig. 84; Moldenke, Sixth Summary Verbenac. etc. Phytologia Mem. II (1980) 337, 553; Moldenke, Phytologia 52, No. 2 (1982) 125; Moldenke in Dassan & Fosberg, Fl. Ceylon 4 (1983) 225; A.D. Chapm., Aust. Pl. Name Index. K–P (1991) 1746; A.C. Smith, Fl. Viti. Nova 5 (1991) 173 – *fide* R.A. Howard (1989), W.L. Wagner et al. (1990).

Type: As for *L. aculeata* L.

L. scandens Moldenke, Phytologia 2 (1941) 18 – *fide* D.N. Gibson (1970).

Type: *George B. Hinton 12315*, at Villa Victoria, Pto de Aire, alt. 1480 m, Coalcoman, Michoacán, Mexico, 3.x.1938 (NY, Herb. N.L. Britton, n.v.) – *fide* Moldenke (1941).

L. camara L. var. *flava* (Medik.)Moldenke, Geog. Distrib. Verbenac. & Avicenn. (1942) 77; Specht in Specht & Mountford, Rec. Amer. Aust. Sci. Exped. Arnhem Land, 3 Bot. & Pl. Ecol. (1958) 289; H. St. John, Hawaii. Fl. Pl. (1973) 290 – *fide* W.L. Wagner et al. (1990).

Type: As for *L. flava* Medik.

L. camara L. var. *hybrida* (Neub.)Moldenke, Phytologia 2, No. 1 (1941) 18; H. St. John, Fl. Pl. Hawaii. Isls (1973) 290 – *fide* W.L. Wagner et al. (1990).

Type: As for *L. hybrida* Neub.

L. camara L. var. *splendens* (Medik.)Moldenke, Phytologia 33 (1976) 130; Moldenke in Dassan. & Fosberg, Fl. Ceylon 4 (1983) 223; A.D. Chapm., Aust. Pl. Name Index K–P (1991) 1747.

Type: As for *Lantana splendens* Medik.

L. camara L. f. *flava* (Medik.)Moldenke, Phytologia 45, No. 3 (1980) 296.

Type: As for *L. flava* Medik.

L. camara L. f. *mista* (L.)Moldenke, Phytologia 45, No. 3 (1980) 296.

Type: As for *L. mista* L.

L. camara L. f. *mutabilis* (Hook.)Moldenke, Phytologia 45, No. 3 (1980) 296.

Type: As for *L. nivea* Vent. var. *mutabilis* Hook.

L. camara L. f. *sanguinea* (Medik.)Moldenke, Phytologia 45, No. 3 (1980) 296.

Type: As for *L. sanguinea* Medik.

L. camara L. f. *splendens* (Medik.)Moldenke, Phytologia 45, No. 3 (1980) 296.

Type: As for *L. splendens* Medik.

Description (Fig. 1)

A sprawling or scandent shrub, 1–3 (-6) m tall, often forming dense thickets. *Stems* and branches ± quadrangular when young, slightly or copiously armed with short recurved prickles, sometimes almost unarmed, puberulous-glabrate, hirtellous or strigose, sometimes mixed with glands or glandular hairs. *Leaves* petiolate, decussate-opposite; lamina ovate, oblong-ovate, membranaceous-chartaceous, (3.5-) 4–10 (-12) cm long, (1.5-) 3–6 (-8) cm wide, often bullate-rugose or scabrous to scabrous-rugose with coarse tubercle-based hairs above, viscid-tomentose to strigose or glabrescent beneath, margin crenate-serrate, apex acute-acuminate, base rounded, subcordate or attenuate and abruptly decurrent, primary and secondary veins flat or slightly impressed above, prominent beneath, secondary veins 5–8 pairs; petiole (3-) 5–20 (-25) mm long, strigose or hirsute, sometimes mixed with glands or glandular hairs. *Inflorescences* densely flowered heads, pedunculate, axillary, solitary or sometimes with 2 peduncles per leaf-axil; heads capitate, hemispheric, many flowered, scarcely elongating after anthesis, 10–20 (-30) mm diam., the peduncle slender, (20-) 30–80 (-95) mm long, appressed pilose or puberulous; bracts linear-lanceolate to lanceolate or lanceolate-oblong, (3-) 4–6 (-8) mm long, 1–1.5 mm wide, usually shorter than the corolla-tube, subulate or acute apically, appressed strigose-pubescent outside, subglabrous inside, deciduous in fruit. *Flowers* sessile, bracteate. *Calyces* small, inconspicuous, membranous, almost truncate or weakly 2-lobed, pubescent mixed with minute glands outside, glabrous inside, 1–2 mm long, 0.8–1 mm wide. *Corollas* hypocrateriform, variously coloured, ranging from yellow, orange-yellow, deep orange, deep red, pink, rose-pink to white with a yellow throat or some with faint pinkish tinge, pubescent outside, subglabrous or puberulous inside the inflated part of the tube; tube cylindrical, somewhat curved and inflated from middle upwards, 7–10 (-12) mm long, (0.5-) 1–1.5 mm diam.; limbs 5–10 mm wide; lobes broadly elliptic-orbicular in outline, 1–3 mm long, 2–5 mm wide near base. *Stamens* inserted just above the middle of the corolla-tube; filaments glabrous, 0.5–1 mm long; anthers orbicular in outline, ± 0.5 mm long. *Ovaries* ellipsoid, glabrous, 0.5–1 mm long; style included, filiform, glabrous, 2–3 mm long, stigma oblique or sublateral,

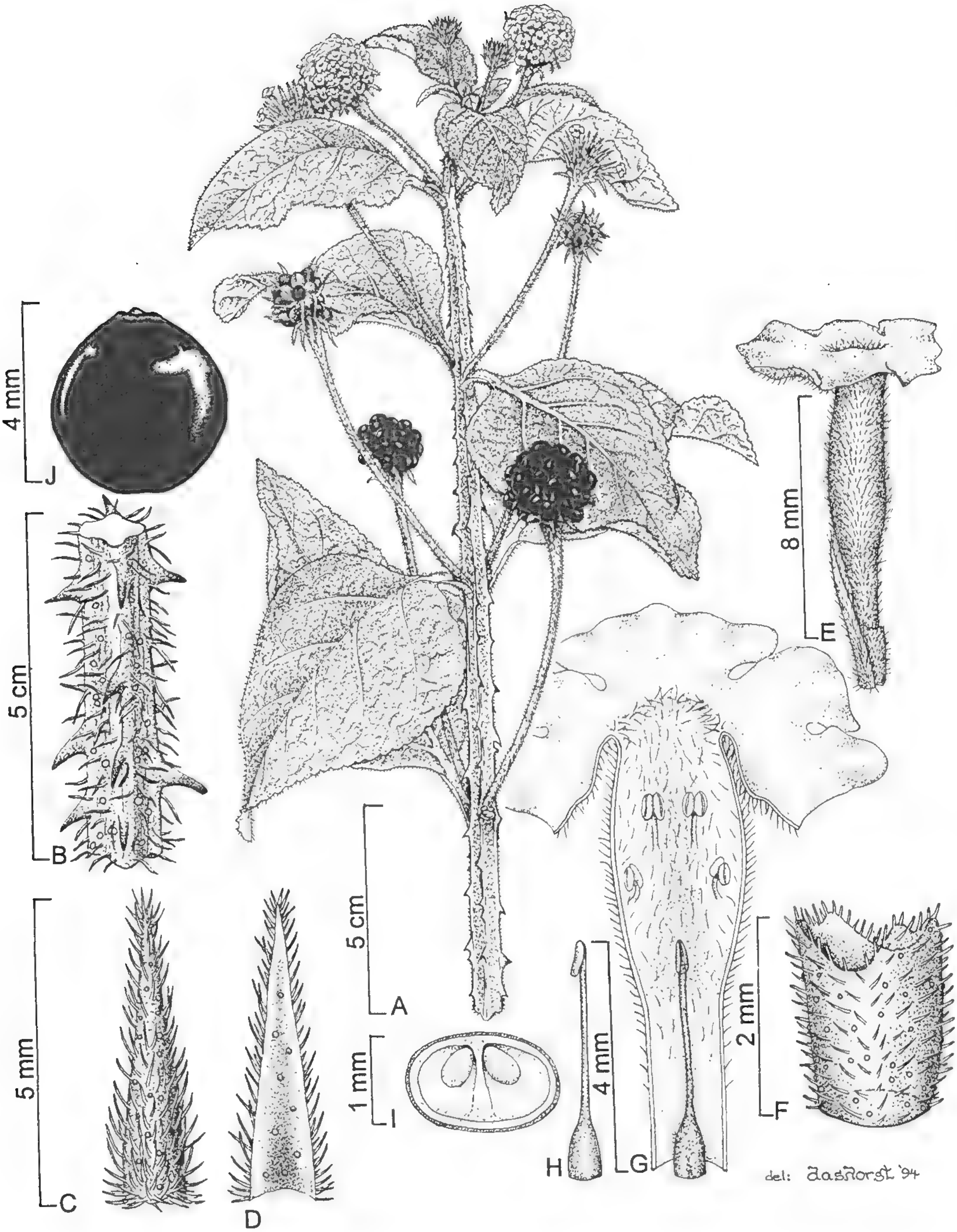


Fig. 1. ***Lantana camara*** L. var. ***camara*** (**A–J**, *W.J. Jones 1635*: CANB). **A,** habit sketch of a branch with flowers and fruit; **B,** portion of stem showing spines and hairs; **C,** abaxial view of bract; **D,** adaxial view of bract; **E,** flower with bract; **F,** calyx showing two shallow lobes; **G,** longitudinally cut open corolla showing androecium and gynoecium; **H,** gynoecium showing oblique stigma; **I,** transverse section of ovary; **J,** fruit.

minute, capitate. *Fruiting-heads* up to 15 mm long. *Drupes* purple or black, ellipsoid-globose or obovoid, glabrous, lustrous, partly enclosed by the bracts and calyx, 3–5 mm diam.; pyrenes 2, ovoid, 3–4 mm long.

Representative specimens (collections seen: Australian 295, non-Australian 362)

AUSTRALIA: QUEENSLAND: *Batianoff 11395, Champion s.n., Thompson s.n. & Dilleward s.n.*, Chase Point, South Percy Island, 50 km NE of Arthur Point, Shoalwater-Bay, 25.x.1989 (BRI); *Briggs 1932*, 1.6 km S of Milla Milla, Atherton Tableland, 1.viii.1968 (NSW); *Clarkson 3877*, Boigu Island, 20.x.1981 (BRI, K); *Clarkson 6337*, 40 Mile Scrub, c. 4 km N of Gulf Development Road turnoff on the Kennedy Highway, 21.ii.1986 (AD, BRI, DNA, L, PERTH, QRS); *Everist 7657A*, Frenchville, suburb of Rockhampton, 25.viii.1964 (BRI, CANB, NSW); *Halliday 352*, Tusky Creek, 12 km SE of Rosedale on Bundaberg Road, 4.iv.1975 (BRI 2 spec., HO); *Lazarides 4240*, near Atherton Township, 1.iii.1954 (BRI, CANB 2 spec., K, MEL, NSW); *Moriarty 891*, St Lucia, Brisbane, 29.iii.1972 (BRI, CANB); *Moriarty 1524*, Alloah Ridge in Canungra Army Jungle Training Centre, SE of Canungra township, 25.iii.1974 (BRI, CANB); *Rogers s.n.*, Imbil, near Gympie, 5.v.1979 (BRI 470124); *Seawright 7*, Limestone Creek Bridge, Rockhampton district, 14.xi.1961 (BRI); *Simmonds s.n.*, Brisbane, Toowong, 22.x.1887 (BRI); *Smith 13121*, c. 1 km along Collins Av. Edge Hill, Cairns, 29.iii.1966 (BRI); *Specht 816 & Reeves s.n.*, upper Kandanga Creek, W of Cooroy, 16.iii.1989 (BRI); *Stoddart 4363*, Low Island, Sandy Cay, 29.viii.1973 (BRI, K); *White 8829*, Oonoobah, near Townsville, 25.iii.1933 (BRI).

NEW SOUTH WALES: *Auld 1202*, Yamba, small island at W end middle sea wall in mouth of Clarence River, 18.iv.1982 (NSW); *Beckler s.n.*, Hastings River, 1869 (MEL 583702, MEL 583705); *Coveny 11147 & Thomas s.n.*, La Perouse, 7.vii.1982 (K, L, MO, NSW 283270); *Coveny 6414 & Powell s.n.*, loc. cit., 3.vi.1975 (CANB, G, HY, K, LE, MO, NSW); *Donabauer 7, Dunn s.n. & Coveny s.n.*, Park Beach, Coffs Harbour, 19.xi.1987 (DAO, NSW, PRE); *Forbes 2801*, Kooyong, between Ardilly and Tullymorgan, 21.ii.1985 (MEL, NSW); *Goode 348*, Sans Souci near Georges River, 27.ix.1961 (K, NSW); *Hawkes s.n.*, Ulladulla, 2.ii.1965 (NSW 283604); *L. Johnson s.n. & Rodd s.n.*, Kurmond, 14.iii.1973 (BRI, NSW 128275); *O'Ryan 73*, 6 km from Nowra, at Albatross Road and Flat Rock Creek crossing, 13.viii.1984 (AD, CBG, L, MEL, US); *Rodway s.n.*, Nowra, 29.iv.1942 (K, NSW 283607); *Symon 11532*, Manarm Creek near Repton, 22.i.1979 (AD, BH, L, LG, NSW); *Wilson 1583 & 1584*, 18 km SW of Warbro and Toorooka on Kookaburra Road, 23.iv.1976 (K, NSW 2 spec.).

NORTHERN TERRITORY: *McKean B288*, The Esplanade, Darwin, 6.ii.1972 (CANB, DNA, K); *Nelson 1085*, Fannie Bay, Darwin, 9.vi.1964 (AD, BRI, DNA, PERTH); *Russell-Smith 5937 & Lucas s.n.*, Holmes Jungle, Darwin, 18.viii.1988 (DNA); *Specht 159*, Nightcliff, Darwin, 3.iv.1948 (AD, BRI, CANB).

VICTORIA: *Mulvaney s.n.*, Frankston, on railway line embankment near Frankston Flinders road, 19.xii.1986 (MEL 234520).

SOUTH AUSTRALIA: *Bates 14529*, Anstey Hill Reserve, 25.vi.1988 (AD); *Black s.n.*, Waterfall Gully, c. 10 km ESE of Adelaide, -.ii.1904 (AD).

WESTERN AUSTRALIA: *Clark 29*, 80.47 km S of Cloister Ave, Canning River foreshore, 30.vii.1974 (PERTH).

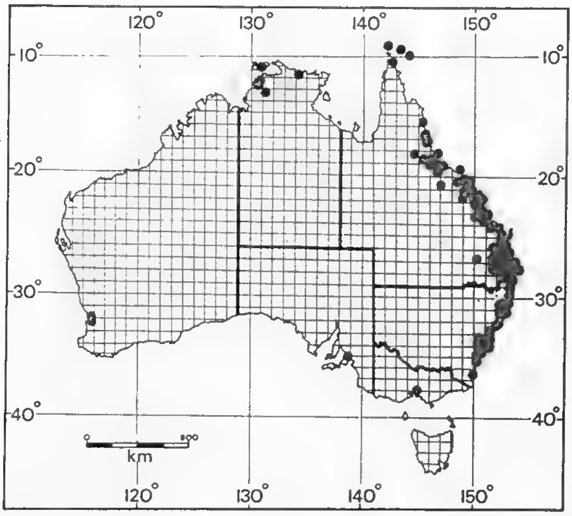
NORFOLK ISLAND: *Hoogland 11-279*, along Duncombe Road near Captain Cook Monument, 31.x.1967 (CANB).

Distribution and ecology (Map 1)

In Australia, *L. camara* var. *camara* is found chiefly in coastal regions of Queensland, New South Wales and the Northern Territory, with only a few records from other mainland States. Distribution in Queensland is along the east coast, particularly between Cooktown and the New South Wales border. Further north, it has been collected from the tip of Cape York Peninsula and several islands in the Torres Strait. This species has also been recorded from several off-shore islands along the Great Barrier Reef.

In New South Wales it occurs in the coastal area from the Queensland border to Narooma township but especially to the north. In the Northern Territory it occurs around Darwin, Adelaide River township, Maningrida Settlement and on Melville Island. In Western Australia it has been collected from the suburbs of Fremantle and Perth, and in South Australia mainly from eastern and northern metropolitan suburbs of Adelaide. The only known collection from Victoria (Melbourne) seems to be a garden escape. So far, no naturalised record of this species is known from the interior of mainland Australia or Tasmania. Parson & Cuthbertson (1992) have recorded it from near Broome, Carnarvon, Geraldton and south-east of Perth, and Swarbrick (pers. comm.) reported it "naturalised on

limestone cliffs in Kings Park" in Western Australia. The present author, however, has not seen any specimens from these areas.



Map 1. Distribution of *L. camara* var. *camara* in Australia

Naturalised material from outside Australia has been examined from Lord Howe Island, Norfolk Island, Marshall Island, Nauru, Papua New Guinea, New Caledonia, Tonga, Samoa, Tahiti, Fiji, Hawaii, Indonesia, Malaysia, Thailand, Philippines, China, India, South Africa, West Indies and Central America. According to Moldenke (1983), this taxon is "widely distributed in subtropical and tropical America from Florida, through the West Indies and S. America to Argentina, Bolivia and Peru; less common in Central America; introduced and naturalised in many other warmer parts of the world".

Moldenke (1982) recorded *L. camara* var. *aculeata* from Tasmania and *L. camara* var. *moritziana* (Otto & Dietr.)López-Pal. from Queensland. The cold climate of Tasmania seems unsuitable for the naturalisation of *L. camara* or perhaps any *Lantana* species, while the occurrence of var. *moritziana* in Queensland has not been confirmed so far.

According to Australian collectors' field notes, *L. camara* grows in diverse habitats. It is found in clay, sand, loam, sandstone, gravel or a mixture of these soil types. Generally it occurs in disturbed areas, such as open-forest areas recovering from fire, on wastelands near railway tracks, along roads, edges of cleared rainforest, at the beach front and in open mixed forests. Other recorded environments includes from the edge of mangroves, vine forest, monsoonal forest, mixed agricultural-pastoral areas and grazing paddocks. It has also been found along creek banks, in riverine plant community and on damp areas around dams. Parsons & Cuthbertson (1992) state that "the plant tolerates a wide range of environmental conditions, thriving in both dry and humid climates. Mainly found on rich soils, it occurs on lowlands, mountain slopes and in valleys at altitudes between sea level and 1800 to 2000 metres. It occurs as a weed along roadsides, creekbanks, fence lines, and in waste places and is a common component of weedy pastures, parklands and arable fields; it tolerates shade and may become the dominant understorey in open forests and tropical tree plantations".

Comments

L. camara (s.l.) is the most widespread species in the genus. It occurs widely as a weed in warmer parts of the world and owing to the considerable morphological and cytological variation it presents a complex taxonomical problem. In view of its extremely variable and polymorphic nature botanists have described it under different names. As a result, *L. camara* seems to have the largest number of synonyms in the genus. Due to variation in the many colour forms, it has been widely cultivated as an ornamental. On the basis chiefly of the difference in flower colour and sometimes in conjunction with the shape of corolla-lobes or vegetative characters Smith and Smith (1982) recognised 29 colour forms or taxa to which they gave names from eastern Australia. Previously, this variation, in particular

the many colour forms, lead Howard (1969) to the description of about 650 cultivar names in the genus of which a majority seem to have been within the *L. camara* complex.

Several botanists have expressed their views on the variable nature of *L. camara*. For instance, Jansen-Jacobs (1988) states that "*Lantana camara* is a very variable species. The indumentum varies from strigose to glandular hairs. The fruiting capitula can be not prolonged or conspicuously prolonged. The flower colour can be orange, yellow, lilac or white. All intermediate character states occur. It is to be expected that *Lantana camara* has a large number of synonyms". On the same subject, Macbride (1960) reports that *Lantana* "species [are] apparently not stable and may be fewer than described ...; there are probably about half as many genetic species (or even fewer) than names". A more or less similar view has been expressed by Wagner et al. (1990), Smith (1991) and a few others. The change in shape and size of leaves, size of fruiting capitula, presence or absence of spines and presence of many colour forms has often lead to the description of new taxa. In fact all these characters are variable and intermediates often merge from one infraspecific taxon into another. Perceiving this complexity, Moldenke (1971) states that "probably a lifetime project could be made of a thorough and intensive study of the *Lantana camara* group". He expressed his doubt about "how many taxa can really be distinguished, how can they be keyed out, and what is their relationship to each other? How greatly is hybridity involved here?". So far, no one has come up with a satisfactory answer to these questions.

Regarding problems encountered in the *L. camara* complex, Parsons & Cuthbertson (1992) state that "there is, as yet, no evidence of hybridisation in the field but branches of plants occasionally revert to other forms and breed true. ... As there appears to be little correlation between chromosome number and the morphology of these groups, it was suggested that the South African complex is still in an active evolutionary phase and that most plants are intermediates in a transitional stage of speciation. It follows that attempts to recognise intraspecific entities within the group are unlikely to be successful. The same may be true of Australian material". On the same problem Spies (1984) reports that "*L. camara sensu lato* presents a complex taxonomical problem owing to the considerable morphological variation present within this species. This variation, in particular the many colour forms, has lead to the description of more than 650 cultivars (Howard 1969). These taxa were not distinguished by clear morphological differences and several nomenclatural ambiguities were also included (Stirton 1977)". He further states that "hybridization results in the continuous variation of characters between the parental extremes, and the hybrids may even exceed the parents in some instances. This fact is responsible for the exceedingly difficult task of classifying a hybrid complex according to normal morphological taxonomic procedures". In a later publication, Spies & Stirton (1982) wrote that "experience gained from a number of areas of the tropics over many decades has shown that *L. camara* is not a homogeneous species, but actually consists of a number of forms". On the same topic Sastri (1962) comments that "the varieties and types are so intermixed that it is difficult to differentiate between them morphologically". On the complex variation in *L. camara*, Smith and Smith (1982) comment that "no evidence has been noted of extensive spontaneous hybridisation in the field but some individuals are subject to branch mutation. A mutant branch may be produced with characters sufficiently distinct from the remainder of the plant to be regarded as a different taxon. Seeds from mutant branches have been found to produce plants similar to the mutant branch and in this way a new taxon may become established. The possibility also exists that these mutant branches may be reversion shoots ('throwbacks') representing the original parent material from which the plant that produce them was derived. With variation of such complexity it was found impossible to name each taxon according to the International Code of Botanical Nomenclature particularly since the literature on these plants is so confused. Consequently, for each of the taxa distinguished in eastern Australia, the field names used by Mr. Smith [unpublished reports 1966, 1967] have been cited. These are probably best regarded as cultivar names as defined in the International Code of Nomenclature for Cultivated Plants (1980)".

Moldenke (1940) also records that "*L. camara* is an extremely variable and polymorphic species. Races differ in the size and shape of leaves, the presence or absence of prickles, the amount of pubescence, and the size and color of the flowers". In a subsequent publication, Moldenke (1973) states that *L. camara* is "introduced and naturalized in the tropics and subtropics [mostly as var. *aculeata* (L.)Moldenke] of the Old World where it has become a troublesome weed in some places; widely cultivated in hundreds of cultivars; probably originally West Indian, but now widely misinterpreted". In spite of this awareness, the material referred to *L. camara* has been divided by Moldenke and others into several species and infraspecific taxa. The characters used in distinguishing these taxa, however, are variable and inconstant, and there appears to be every intermediate. Several species previously reduced by Moldenke (1934, 1941, 1947, 1976) to variety level were later (1980) further relegated to the category of form. Thus the value of infraspecific taxa in *L. camara* seems questionable. In an attempt to resolve the infraspecific problem, Spies (1984) undertook a cytotaxonomic study of *L. camara* from South Africa. He applied numerical taxonomic methods to the cytological data obtained from 97 *L. camara* plants, but no correlation was found to exist between the cytological data and plant morphology. According to Spies (1984), "the cytological data demonstrated that *L. camara* is in an active evolutionary phase and, because most plants are intermediates in a transitional stage of speciation, no attempt to recognise infraspecific entities will succeed".

In Australia, the *L. camara* complex can be divided into two major groups, namely thornless and thorny. The thornless group is the major garden ornamental biotype said to produce few if any seeds, whereas the thorny group is the weedy biotype reportedly producing abundant seeds. There are some weedy forms, however, with almost no thorns or sometimes with only a few sparse minute thorns. These plants seem to be intermediate forms and could not be clearly assigned to either group.

In Australian literature, material of var. *camara* has been published under the names: *L. aculeata* L., *L. crocea* Jacq., *L. tiliaefolia* Cham., *L. camara* var. *aculeata* (L.)Moldenke, *L. camara* var. *crocea* (Jacq.)L.H. Bailey, *L. camara* var. *flava* (Medik.)Moldenke, *L. camara* var. *mista* (L.)L.H. Bailey, *L. camara* var. *mutabilis* (Hook.)L.H. Bailey, *L. camara* var. *sanguinea* (Medik.)L.H. Bailey and *L. camara* var. *splendens* (Medik.)Moldenke. Of the above taxa Moldenke (1980) relegated the varieties *flava*, *mista*, *mutabilis*, *splendens* and 9 others to the category of form. In recent publications by others all these taxa have been treated as synonyms of the typical form of *L. camara*. It may be of interest to note that *L. aculeata* L. was first recognised as a synonym of *L. camara* by Schauer (1847). More recently Webb (1948) wrote that "the varieties *sanguinea* and *crocea* are barely separable botanically". Similarly Smith (1991) regarded the varieties *aculeata* and *mista* as "dubiously separable" taxa. Several other taxonomists have expressed their doubts on the status of the above named infraspecific taxa. As no reliable character is available to distinguish them taxonomically, therefore, they are being treated here as synonymous with the typical form.

Enormous literature has been devoted to *L. camara*, and many botanists have declared it a dangerous weed in very many parts of the tropics. In this respect, only a few comments made by Australian and overseas botanists are recorded here. Bailey (1906) wrote that "the plant has overrun many of the river scrubs, and become a well-known pest". Gamble (1956) reports that "the plant is most troublesome and measures for its destruction are often necessary though difficult". In the book on 'Gardening in East Africa', Jex-Blake (1957) states that "this plant is now scheduled as a dangerous weed, and, pretty as it is when in flower, should be extirpated on sight". According to Irvine (1961), "it is a most troublesome weed in parts of Ghana and elsewhere in tropics, and has proved a serious obstacle to forest regeneration in some districts". Duthie (1960) says that as an undergrowth in forest, although beneficial to some extent as offering shelter to young trees, it has nevertheless proved itself to be a very troublesome weed in deciduous forests, and very difficult to eradicate". Gibson (1970) reports that "this is a common weedy shrub in much

of tropical America". She considers it "a weed of banana plantations, often invading cultivated ground". Parsons & Cuthbertson (1992) state that in Australia the "weedy biotypes [of *L. camara*] are very serious weeds of pastures, citrus groves, ... and, sometimes, timber crops. They are estimated to infest some 4 million ha in Australia and have taken over many pasture areas, shading out useful species and reducing productivity". Attention is drawn by Howard (1969) to a poster distributed by the Department of Agriculture in Rhodesia (Zimbabwe) pleading for the extermination of *L. camara*. It reads "***Lantana camara***. A perfect pest! Get rid of it Now".

From an economic point of view, *L. camara* is said to form a useful hedge and is a popular garden plant for its spectacular coloured flowers. The leaves and flowers have a mint-like odour and are used as tea against fever, influenza and stomach ache. According to Irvine (1961), "the powdered root in milk is given to children for colic and stomach ache, and an infusion of the whole plant used for bronchitis and other catarrh infections. The leaf decoction is drunk there [in Ghana] for constipation and as a febrifuge and is applied externally to ophthalmia and festering sores, or used in baths and hot fomentations for dropsy. An aromatic oil from the leaves is used in fomentations (Ainslie). An aromatic infusion of leaves and flowering tops, sometimes with *Ocimum*, is used especially by W. Indian resident in W. Africa, as a febrifuge and diaphoretic. The leaves, with leaves of the banana and *Morinda lucida* and other herbs, are boiled together and the body steamed over the pot for 'yellow fever'. A quinine-like alkaloid, *lantanine,* has been isolated from this plant, the effect of which is anti-spasmodic". White (1929) states that "the red flowering variety (*L. camara* var. *sanguinea*) is by far the more virulent. *Lantana* causes a disease in cattle known colloquially as 'pink-nose'. In the opinion of Jex-Blake (1957), "the hybrid Lantanas are safe; but that pernicious weed, the pretty pink-purple-yellow-flowered *Lantana camara*, should never be planted anywhere". Standley (1924) reports that "the plant blooms nearly all the year. The fruit is sweet and edible but not very palatable. A decoction of the leaves is sometimes employed as a remedy for rheumatism and as a tonic for the stomach. The plant is a favourite remedy for snake bites, a strong decoction of the leaves being taken internally and a poultice of crushed leaves applied to the wound". A field note with J.H. Camfield's (s.n.) collection (NSW 28328) from Woolloomooloo, N.S.W., states that *Lantana camara* is "mainly a weed of the North Coast. Somewhat difficult to eradicate, but it is generally considered as a good preparation for crops. Whilst useless in itself, it covers the ground below with a fine leaf mulch". A more or less similar view is expressed by Moldenke (1983) who records that "although this plant is usually regarded as a pest it may prove beneficial under certain conditions in forests. It improves the fertility of exhausted areas of rocky, gravel, or hard laterite soils. It enriches the soil and serve to retain humus in deforested areas and check soil erosion. It may serve as a nurse for sandalwood seedlings if not too dense and in the Pacific islands is used as support for yam vines. In India the leaves and twigs are often used as green manure (mulch) in forest areas and for paddy crops; they can also be composted along with other materials. Lantana ash is rich in soluble potassium salts and manganese and is useful for manuring coconut trees. The entire plant is bitter because of an active principle called 'Lantanin' ... . The plant is not readily eaten by cattle, but may be browsed when pasturage is very scarce and may then result in symptoms of severe jaundice, exfoliation of the skin near the muzzle, profuse salivation, severe dermatitis, copious lachrymation, and loss of appetite in the cattle. The ripe fruits are eaten by children in many lands and can be employed as a flavouring. The stems are used as a tooth brush and the leaves for polishing wood" ... etc.

Verdcourt (1992) claims that this species is a "rather unpleasantly aromatic shrub 0.35–5 m tall but can be scandent to 12 m or even in cultivation over a long period become a tree to 8 m with a bole of 10–12 cm diameter". So far, such a long stem and thick bole has not been recorded in any *L. camara* collection in Australia.

According to Curtis (1790), Irvine (1961) and Howard (1969), *L. camara* can be propagated easily by seeds and/or cuttings.

Throughout its range, *L. camara* is known by more than 150 vernacular names. Some of the popular English names are : "common Lantana", "camara", "English sagebush", "sweet sage", "red sage", "yellow sage", "white sage", "wild sage", "Jamaican mountain sage", "Bahama tea" and "prickly Lantana".

Affinities

Of all *Lantana* species, *L. camara* seems more closely related to *L. moritziana* Otto & Dietr. in its inflorescence being capitate, not elongate spicate, flat or globose when mature, lower bracts not conspicuously larger than the rest nor broadly ovate, and indumentum on stems, peduncles, and foliage neither long-hirsute nor setulose. Nevertheless, *L. moritziana* may easily be distinguished by its indumentum on branches and peduncles being densely but minutely hirsute, and leaves usually densely puberulous or short-pubescent on both surfaces, especially beneath. In *L. camara*, the hairs on peduncles and branches are minute and inconspicuous and the leaves are usually scabrous above and sparsely pilose or strigose beneath and sometimes glabrescent.

There are some characters common between *L. camara* and *L. hodgei* Sanders. In both species the receptacle of the inflorescence rachis is fistulate and dilated relative to the peduncle; drupes blue-black; endocarp inflated with large hollow central chamber separating and many times larger than seed cavities, and hairs on lower surface of leaf blades restricted mostly to primary, secondary and tertiary veins. Nevertheless, *L. hodgei* may readily be identified by its leaf blades being mostly 1.5 to 2.5 times longer than wide, base shortly attenuate; upper surface at maturity lustrous, dark green, smooth, non-rugose, the hairs small, weak and often deciduous; lower surface pale grey-green, almost glabrous or with weak hairs strongly appressed to the surface, the secondary and tertiary veins weakly or not at all keeled.

2. **Lantana montevidensis** (Spreng.)Briq., Ann. Conserv. & Jard. Bot. Genéve 7–8 (1904) 301; Moldenke, Résumé Verbenac. etc. (1959) 119, 209, 459; N.C.W. Beadle, O.D. Evans & Carolin, Handb. Vasc. Pl. Syd. Distr. & Blue Mtns (1963) 416; M. Neal, Gard. Hawaii, Rev. edn (1965) 724; R.J.F. Hend., Contr. Qld Herb. No. 3 (1969) 1, figs 1 & 2; Moldenke, Fifth Summary Verbenac. etc. 1 & 2 (1971) 152, 189, 347, 887; H. St. John, Fl. Pl. Hawaii Isls (1973) 290; Kleinschmidt & R.W. Johnson, Weeds Qld (1977) 37, 260; López-Pal., Fl. Venezuela Verbenac. (1977) 401, fig. 94; Moldenke, Phytologia Mem. 2, Sixth Summary Verbenac. etc. (1980), 337, 556; Everist, Poison. Pl. Aust. (1981) 747; S.W.L. Jacobs & Pickard, Pl. N.S.W. (1981) 209; N.C.W. Beadle, O.D. Evans & Carolin, Fl. Syd. Reg. 3rd edn (1982) 510; Moldenke in Dassan. & Fosberg, Fl. Ceylon 4 (1983) 215; N.C.W. Beadle, Stud. Fl. NE N.S.W., Part 4 (1984) 850; Lord & J.H. Willis, Macq. Dic. Trees & Shrubs (1986) 267; Stanley in Stanley & E.M. Ross, Fl. SE Qld 2 (1986) 365; Swarbrick, Pl. Protect. 1 (1986) 118, 119; Auld & R.W. Medd, Weeds (1987) 235; Hnatiuk, Cens. Aust. Vasc. Pl. (1990) 627; W.L. Wagner et al., Fl. Pl. Hawaii 2 (1990) 1320; A.D. Chapm., Aust. Pl. Name Index K–P (1991) 1747; A.C. Sm., Fl. Viti. Nov. 5 (1991) 173; W.T. Parsons & E.G. Cuthbertson, Noxious Weeds Aust. (1992) 632; Lazarides & Hince, Econ. Pl. Aust. (1993) 144; Pedley in R.J.F. Hend. (ed.), Qld Vasc. Pl. (1994) 336.

Type: *"Sellow s.n.*, from Montevideo, Uruguay, collected in 1822 (M. Orro herbarium)" – *fide* Moldenke (1983), n.v.

Lippia montevidensis Spreng., Syst. Veg. 2 (1825) 751, **basionym**; Spreng., Syst. Veg. 4, Part 2 (1827) 231; Schauer in DC., Prod. 11 (1847) 594.

Type: As for *Lantana montevidensis* (Spreng.)Briq.

Lantana sellowiana Link & Otto, Icon. Pl. Sel. Hort. Reg. Bot. Berol. (1826) 107, t. 50; Hook., Bot. Mag. N.S. 4 (1830) t. 2981; Cham., Linnaea 7 (1832) 126; Schauer in DC., Prod. 11 (1847) 604; Schauer in Mart., Fl. Brazil. 9 (1851) 261; F.M. Bailey & Ten.-Woods, Proc. Linn. Soc. N.S.W. 4 (1879) 174; F.M. Bailey, Synop. Qld Fl. (1883) 376; F.M. Bailey, Qld Fl. 4 (1901) 1171; F.M. Bailey, Weeds & Suspec. Poison. Pl. Qld (1906) 141; F.M.

Bailey, Compr. Cat. Qld Pl. (1913) 382; C.T. White, Qld Agric. J. Ser. 2, 27 (1927) 148; C.T. White, Qld Agric. J. 31 (1929) 294; E.I. Hurst, Poison Pl. N.S.W. (1942) 341; L.J. Webb, Bull. Council Sci. Industr. Res. No. 232 (1948) 169; A.D. Chapm., Aust. Pl. Name Index K–P (1991) 1747. – *fide* Briquet (1904), Moldenke (1959, 1971 & 1983).

Type: See under typification.

Lippia megapotamica Spreng., Syst. Veg. 4, Part 2 (1827) 231; Schauer in DC., Prod. 11 (1847) 593 – *fide* Moldenke (1959, 1971, 1983).

Type: "*Sellow*" *s.n.*, "Rio grande" (n.v.). According to Stafleu & Cowan (1985) "Kurt Sprengel's considerable and rich herbarium (21,806 species) came first to his son Anton. After the latter's death, in 1851, it was sold in parts. ... A certain number of families and genera were sold to specialists, so e.g. ... the Labiatae and Verbenaceae to J.A. Schmidt in Heidelberg" (HEID). The latest edition of "Index Herbariorum" (edn 8) records the J.A. Schmidt herbarium going to Institute für Allgemeine Botanik in Hamburg (HBG).

Lantana delicatissima Poit. ex Gouault, Rev. Hort. Ser IV, 1 (1852) 461 – *fide* López-Pal. (1977), Moldenke (1959, 1971, 1983).

Type: (n.v.). No type cited in the protologue.

Camara sellowiana (Link & Otto)Kuntze, Rev. Gen. Pl. 2 (1891) 504 – *fide* Briquet (1904), Moldenke (1959, 1971, 1983), López-Pal. (1977).

Type: As for *Lantana sellowiana* Link & Otto.

Camara montevidensis (Spreng.)Kuntze, Rev. Gen. Pl. 3 (1898) 250 – *fide* Briquet (1904), Moldenke (1959, 1971, 1983), López-Pal. (1977).

Type: As for *Lantana montevidensis* (Spreng.)Briq.

Typification

In the protologues of *Lippia montevidensis* Sprengel and *Lantana sellowiana* Link & Otto the cited types are respectively: "Monte Video. Sello" and "Semina hujus plantae e Montevideo anno 1822 misit cl. Sellow, nomine Lantanae decumbentis, quam in honorem viri sagacissimi mutavimus". It is interesting to note that at the same time that Friedrich Sello (erroneously Sellow) sent the herbarium voucher to Sprengel at the Museum in Berlin, he sent seeds of the same plant to H.F. Link at the botanical gardens in Berlin, which were separate from the museum at that time. Link and F. Otto subsequently described the same specimen as *Lantana sellowiana* with a drawing (plate no. 50). According to Smith (1991), "it is probable that both *Lippia montevidensis* and *Lantana sellowiana* were based on the same specimen collected about 1822 in Montevideo, Uruguay, and said to be in the M. Orro herbarium (Moldenke, 1983)". It is worth mentioning here that between 1820 and 1828, Uruguay was part of Brazil and became an independent State only in 1828 [Encyc. Brit. vol. 22 (1958) 905].

Regarding the types of the above named taxa, enquiries in the herbaria at B, BM, HBG, HEID, K, TEX, U, US and personal communication with Dr. Moldenke have failed to locate the types or the whereabouts of the M. Orro herbarium. A photograph in Herb. US of one of Sellow's voucher specimens has been annotated by H.N. Moldenke as "Photograph of TYPE of *L. sellowiana* Link & Otto". The herbarium label of this photograph clearly shows that the plant was collected by Sellow from "Brasilia" and the voucher specimen was distributed "ex Herb. Reg. Berolinense". The whereabouts of the specimen, however, is not indicated. The name "*Lantana sellowiana* Link et O" written on the label seems to be in the handwriting of one of the authors. As mentioned earlier, at the time of describing this taxon, Link and Otto were based at the botanical gardens in Berlin and Sellow's specimen was most likely used by them in preparing the original description of this taxon. If the holotype in Herb. B was destroyed during the war and no material of the type collection exists, then the drawing (t. 50) published with the protologue of *L. sellowiana* may be a satisfactory replacement for the type.

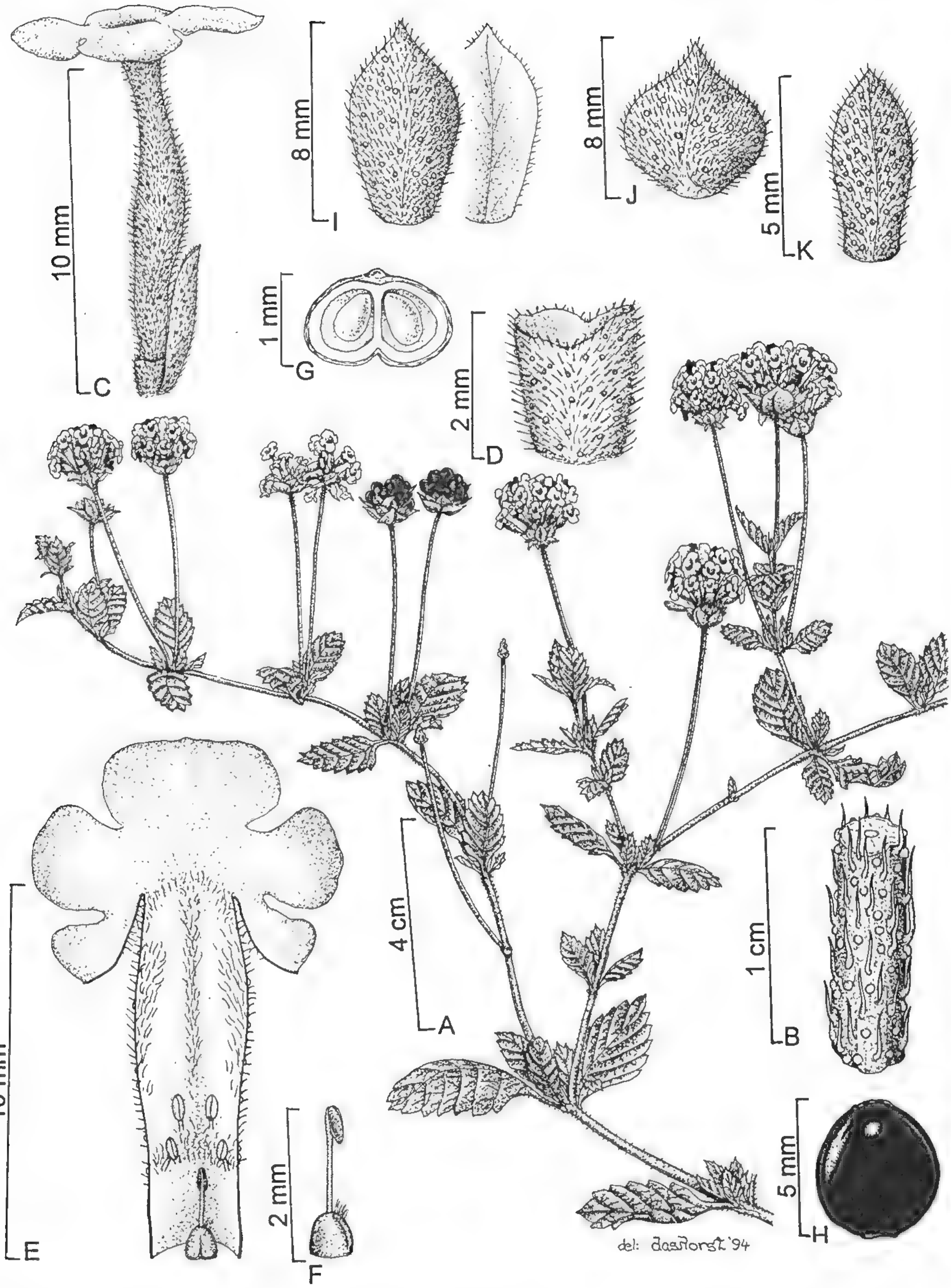


Fig. 2. ***Lantana montevidensis*** (Spreng.)Briq. (**A–K,** *A.R. Bean 6734*: BRI). **A,** habit drawing of a branch with flowers and fruit; **B,** portion of stem showing hairs and glands; **C,** flower with bract; **D,** calyx with 4 shallow teeth; **E,** longitudinally cut open corolla showing androecium and gynoecium; **F,** gynoecium with oblique stigma; **G,** transverse section of ovary; **H,** fruit; **I,** middle bract showing abaxial and adaxial view; **J,** out bract showing abaxial view; **K,** inner bract showing abaxial view.

Description (Fig. 2)

A creeping, trailing, decumbent or scrambling woody herb or low shrub, often mat-forming with very short but profusely flowered branches. *Stems* weak, 1–2 (-4) m long, 1–2 mm diameter and obtusely 4-angled first, but becoming subcylindrical and up to 7.5 mm diameter with age; branches usually slender, rooting at nodes that touch the soil, without prickles, subterete, strigose or hirsute-pubescent. *Leaves* decussate-opposite or sometimes ternate, shortly petiolate; lamina variable in size and shape, ovate, subrhomboid-oblong to ovate-lanceolate, (8-) 10–25 (-35) mm long, (5-) 8–17 (-20) mm wide, subacute to obtuse at apex, cuneate to attenuate into the petiole, crenate-serrate at margin, bright-green, rugose and scabrous or hirsute above (adaxially), densely resinous-glandular and tomentose below (abaxially), veins prominent and strigose below; petiole pubescent, 1–4 mm long. *Inflorescences* pedunculate, arising in the leaf axils, initially capitate and hemispheric, becoming oblong in fruit, 10–25 ("-40") mm in diameter; peduncle longer than subtending leaves, pubescent, (15-) 20–80 (-100) mm long; *bracts* sessile, imbricate, herbaceous, concave, ciliate, resinous-punctate and strigose-hirtellous outside (abaxially), glabrous inside (adaxially), persistent, the outer ones somewhat rhomboid, broadly ovate-elliptic to oblong-ovate or sometimes almost orbicular, eventually spreading, 4–8 mm long, 2.5–5 mm wide, the inner ones successively narrower and smaller, ± oblong. *Flowers* sessile, bracteate, about 20 in each flattish capitulum. *Calyces* small, membranous, obscurely 4-toothed, subvillous-pubescent and resinous-punctate outside, glabrous inside, 1–2 mm long, ± 1 mm diameter. *Corollas* infundibular, slightly irregular, 4-lobed, varying from pink, lilac to violet, rose, purple, magenta or white or yellow form in cultivation, pubescent and resinous-punctate outside, villous inside the tube; tube slender, cylindrical, almost straight, slightly dilated about the middle, yellowish at the base, longer than the subtending bracts, conspicuously exserted in anthesis, (5-) 7–10 (-12) mm long, 1–2 mm in diameter; lobes spreading to 10 mm diameter, each lobe reniform-orbicular in outline, blunt or emarginate, 3–5 (-8) mm long, (2-) 3–5 (-8) mm wide, the upper one the largest, the side-lobes the smallest and equal. *Stamens* included, attached about the middle of the corolla-tube; filaments short, glabrous, ± 0.5 mm long; anthers ellipsoid, up to 0.5 mm long. *Ovaries* ellipsoid-globose, glabrous excepting a few small hairs on one side at the top, 0.5–1 mm diameter; style included, filiform, glabrous, 1–1.5 (-2.5) mm long; stigma oblique, minute. *Drupes* ellipsoid-globose, fleshy, half enclosed by calyx, green at first, purplish-black or dark-violet when ripe, 3–6 (-8) mm long, 2–5 (-8) mm diameter, the endocarp woody, 2-loculed, splitting septicidally into 2 pyrenes, the seeds incrassate dorsally.

Representative specimens (collections seen: Australian 58, non-Australian 60)

AUSTRALIA: QUEENSLAND: *Anderson s.n.*, Kholo, near Brisbane River, 13.iii.1961 (BRI 027188); *Bean 6734*, Glastonbury Creek, 1.5 km NE of Glastonbury, 7.x.1993 (BRI); *Blake 2300*, Coot-Tha Mt, Brisbane, 16.iii.1931 (BRI). *Court 57*, Rockhampton, 2.viii.1925 (BRI); *D. Cunningham 1024*, Port Curtis District, SW of Agnes Water near Mt Maria, 13.xi.1993 (AD, BRI, NSW); *Durrington 1373*, Fisherman Islands, mouth of the Brisbane River, c. 6.5 km N of Wynnum, -.xii.1973 (BRI); *Epps 90* (F.55/321), Gin Gin Res. 169, St Agnes, -.ii.1955 (BRI); *Everist 7657A*, Frenchville, Rockhampton, at the foot of Mt Archer, 25.viii.1964 (BRI, K); *Gibson T01560*, State Forest 150, Beecher, 10 km SW of Gladstone, 15.iv.1989 (BRI); *Henderson H448*, ground of D.P.I. Indooroopilly, Brisbane, 19.ix.1968 (BRI); *Johnson 20420*, Mt Gravatt, 3.vi.1951 (K, NSW); *Jones 3342*, Waterford, S Queensland, -.xii.1966 (CANB); *Medd 161135*, Lockyer Creek, W of Gatton, 11.viii.1983 (NSW); *Melzer 14*, Mt Zamia Environmental Park, Springsure, 7.iii.1990 (BRI); *Pedley 476*, near Haighmoor Colliery, NE of Ipswich, 9.ix.1959 (BRI); *Poulsen s.n.*, Middle Road, Purga, 21.viii.1969 (BRI 085130); *Rawson R4*, Mt Lockerbie area, near Thangool, 3.i.1968 (BRI); *Salasoo 5497*, Highfields, 12.87 km N of Toowoomba, 30.xii.1974 (NSW); *Sharpe 981*, Griffith University Site, Kessels Road, Mt Gravatt, 1.i.1974 (BRI); *Shaw 5492*, Calliope, 22.x.1947 (CANB); *Simmonds 376*, Ipswich, 15–17.x.1888 (BRI); *Stanley 80196*, Townsville harbour, 13.ii.1980 (BRI); *Stanley 758*, near coal terminal, Gladstone, 20.ii.1980 (BRI); *Thomson 143*, Wambo, -.iv.1931 (K 2 spec.); *Tutt s.n.*, Sandy Creek Road, Downsfield near Gympie, 8.ii.1967 (BRI 065067); *White s.n.*, Gayndah, 13.v.1917 (BRI 268381; NSW 283531).

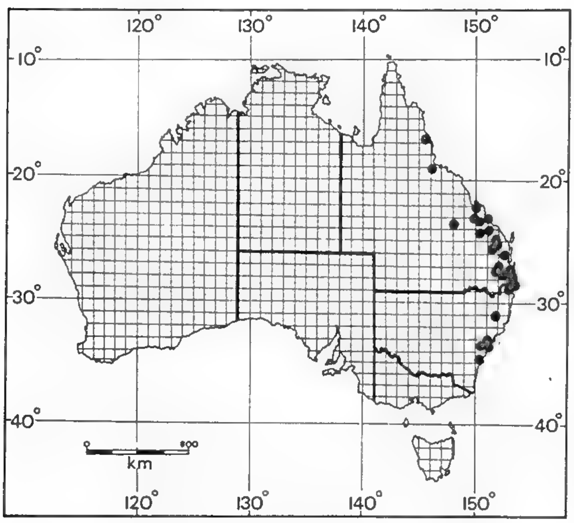
NEW SOUTH WALES: *Auld 120137*, Murwillumbah, 1.ii.1981 (NSW); *Benson 1221 & Rodd s.n.*, N end of Garden Island Naval Depot, Central Coast, 5.iv.1977 (NSW); *Briggs s.n.*, 6.43 km S of Penrith on Mulgoa Road, 20.vii.1964 (NSW); *Craig s.n.*, Byron Bay, N Coast, 8.xii.1968 (CBG 025780); *Hodges s.n.*, Casino district, -.xi.1963 (NSW 283582); *Johnson s.n.*, Northbridge, Sailor's Bay, 4.xi.1967 (NSW 283571); *Mackay s.n.*,

Dyraaba Creek between Casino and Bonalbo, 20.i.1971 (NSW 283577); *Rodway s.n.*, Nowra, 11.v.1942 (NSW 283566).

NEW CALEDONIA: *Franc 502*, Noumea, 30.i.1909 (BM, CANB).

Distribution and ecology (Map 2)

In Australia *L. montevidensis* is known to occur chiefly in the eastern coastal and subcoastal regions of Queensland and New South Wales. Distribution in Queensland is particularly in the area between Cairns and the New South Wales border. The majority of localities within this area are in the "Pastoral Districts" of North Kennedy, Port Curtis, Wide Bay and Moreton. In New South Wales, the main distribution is in the north-eastern part of the State between Casino and the Queensland border, around Sydney and near Nowra township south of Wollongong. Besides, this species has been recorded from Oxley Park near Tamworth. It does occur as an ornamental in some Northern Territory towns where it has not yet been naturalised.



Map 2. Distribution of *L. montevidensis* in Australia

The only collections examined from outside Australia are from New Caledonia, Tahiti, Fiji, Costa Rica, Mexico and Panama. According to Moldenke (1983), however, this taxon is "a native of the area from southern Brazil, through Uruguay and Paraguay to Argentina."

According to Australian collectors' field notes, *L. montevidensis* grows in diverse habitats including well drained wasteland alluvial soil, open *Eucalyptus* forest loamy soil, disturbed areas behind mangroves, open woodland, along roadsides and river banks. It is also recorded from dry sclerophyll forest, red loam, sandy loam over sandstone rocks, on rocky hill near the sea and paddocks on a disturbed holding. Parson and Cuthbertson (1992) state that this species grows in "subhumid to semi-arid regions of the tropics and subtropics, especially on shallow stony soils, readily replacing pasture species affected by prolonged drought". They also claim that "the presence of creeping lantana [i.e. *L. montevidensis*] thickets reduces the available grazing area and, hence, pasture productivity. It is an extremely efficient pioneer species, quickly encroaching on pasture areas weakened by prolonged drought". A more or less similar view has been expressed by Everist (1981) who reports that "it generally grows on rather shallow, often stony soils and during a succession of dry seasons can become an aggressive weed, replacing the native pasture grasses".

Comments

According to Everist (1981), *L. montevidensis* "is widely cultivated in warm countries as an ornamental scrambler, particularly for covering banks". In Australia, "one form has become naturalised in several localities in coastal and subcoastal Queensland and north-east New South Wales". Parsons & Cuthbertson (1992) report that this species is a native of Uruguay and southern Brazil from where "it has been introduced to most other tropical and subtropical regions as a ground-covering ornamental. It is considered a weed only in Australia, especially in Burnet and Wide Bay pastoral districts Queensland, northern New

South Wales and parts of the Sydney region". Its dispersal is said to have been "by fruit-eating animals and birds, water flowing across the soil surface during heavy rain, and in mud sticking to hooves and footwear".

Regarding the properties of this species, Lord & Willis (1986) describe it as "a very useful cover shrub for all but coldest districts" [in Australia]. It is "quick-growing and drought-resistant, it flowers freely for almost the whole year. May be grown in window boxes, garden vases or urns, to cover old palm or tree stumps, as a clipped bed edging or, as is most popular, over rockwork". The plant can be "clipped into shape during spring". Auld and Medd (1987) report that "it is a weed of unimproved pastures. The cultivated form of this species is a common hedge plant. It does not produce fruits".

In a cytological study of *L. montevidensis*, Henderson (1969) states that two forms of this species are known to occur in Australia. The common garden form which does not produce fertile fruits here is a triploid (2n = 36), and the naturalised or wild form which produces viable seeds is a tetraploid (2n = 48). In Swarbrick's (1986) view, "Australia is perhaps the only country outside South America to possess this [i.e. tetraploid] form of the plant". In his opinion, the triploid form is a free-flowering, seedless and "is very widely grown as a garden ornamental, being non-aggressive and capable of being trimmed into a low neat hedge or left to trail attractively over rocks and banks. It is propagated only by stem cuttings. The tetraploid form is similar but less flowery, more prostrate and widespreading in habit, and it readily roots at the nodes when in contact with the ground. It sets seeds freely and can be reproduced by seed, cuttings or division of established plants". He also states that the "creeping lantana [i.e. *L. montevidensis*] was introduced into Australia as an ornamental trailing shrub and subsequently escaped to become a minor weed in coastal and subcoastal New South Wales and Queensland". In the same publication, Swarbrick (1986) further records that "creeping lantana was also widely distributed by man in the 19th century, but it has only become a weed in Australia (Holm et al. 1979) and perhaps in America (Bailey 1927). It was introduced from Montevideo [Uruguay] to Europe in 1822 and not "1828" as recorded by Johnson (1872) and to Australia by 1851 (Shepherd 1851)". The then accepted name for this species was "*L. sellowiana*" or at least in the 1851 catalogues of the Sydney nurserymen Guilfoyle and Shepherd as "*L. sellowii*" and "*L. selowiana*"."

According to Moldenke (1983), "*L. montevidensis* contains camphor, menthol, and bornyl acetate. In South America it is employed in native medicine in the treatment of broncho-pulmonary diseases, headaches, sunstroke, and fevers and is often carried in amulets by the superstitious natives. Hurst (1942) states that feeding experiments with guinea pigs suggest that the ingestion of "reasonable amount" of the plant does not produce photosensitization effects. On the contrary, Everist (1981), Stanley (1986), Parsons & Cuthbertson (1992) and Lazarides & Hince (1993) believe that this species is suspected of cattle poisoning, similar to *L. camara.*

In Australia, the first written record of this species, as a garden escape or weed, was published by Bailey & Tennison-Woods (1879) under the name "*L. selloviana*". Subsequently, Bailey (1883, 1890, 1901, 1906, 1913) recorded this taxon as *L. sellowiana.* According to White (1929), the specific epithet sellowiana is "in honour of Friedrich Sellow, a German botanist who travelled extensively in South America during the early part of the nineteenth century".

This species is known by some 20 vernacular names (Moldenke 1983). The most popular ones are: "Creeping Lantana", "Trailing Lantana", "Weeping Lantana", "purple Lantana", "Small Lantana", "Polecat-Geranium" or "Wild Verbena".

Affinities

L. montevidensis is closely related to *L. indica* Roxb. in its inflorescence being capitate, not elongate-spicate, flat or globose when mature; outer bracts much larger than the rest, broadly ovate, usually ± 5 mm wide, conspicuously involucrate. Nevertheless, *L. indica* may easily be distinguished by being an erect or rambling woody shrub; leaf-blades mostly ovate-lanceolate, acute, softly hairy above (adaxially), densely white-woolly beneath (abaxially); outer bracts often cordate at base, softly and loosely pubescent and corolla mostly "pink or white". On the contrary, *L. montevidensis* is a creeping or decumbent herb or low shrub with stems rooting at the nodes when touching damp soil; leaf-blades mostly rhomboid or very broadly ovate, obtuse or subacute, scabrous-hirsute above (adaxially), resinous-glandular and strigose-pubescent beneath (abaxially); outer bracts not cordate at base, resinous-punctate and strigose-hirtellous; corolla usually bright "magenta or lilac" or in cultivars white or yellow.

L. camara also has capitate inflorescences which do not elongate into a spike and become flat or globose when mature. For differences between these species see "Key to the species".

Excluded name

Charachera Forssk., Fl. Aegypt-Arab. (1775) 115.

This genus was published by Forsskål under the "class Didynamia" without reference to any modern family name. Bartling (1830) placed it in the synonymy of *Lantana* in the Verbenaceae. Subsequently, Schauer (1847), López-Palacios (1977) and Moldenke (1973, 1983) also recorded it as a synonym of *Lantana*. In "Index Nominum Genericorum (Plantarum)", vol. 1 Aa–Ep. (1979), however, *Charachera* Forssk. has been referred to the Acanthaceae and is, therefore, excluded here from the genus *Lantana*.

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Index to Scientific Names

Names: New names and combinations are in **bold**. Synonyms, misapplied, misspelt, illegitimate or invalid names are in *italics*.

Page numbers: Page numbers in **bold** refer to main taxonomic treatment. Page numbers asterisked refer to figures and maps.

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A REVISION OF THE GENUS *KUNZEA* (MYRTACEAE) I. THE WESTERN AUSTRALIAN SECTION *ZEANUK*

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Abstract

Within *Kunzea* sect. *Zeanuk*, 21 species in three subsections are described and accompanied by discussion on their affinities based on morphological and anatomical evidence. Numerous natural putative hybrids are briefly discussed under the taxon placed first in the hybrid formulae. The paper includes publication of (a) 16 new taxa: sect. *Zeanuk*, subsect. *Arborescentes*, subsect. *Floridae*, subsect. *Globosae*, *K. acuminata*, *K. ciliata*, *K. cincinnata*, *K. clavata*, *K. glabrescens*, *K. newbeyi*, *K. rostrata*, *K. similis*, *K. spathulata*, *K. ericifolia* (Sm.)Rchb. ex Heynh. subsp. *subulata*, *K. micrantha* Schauer subsp. *hirtiflora* and subsp. *petiolata*, and (b) one new combination: *K. micrantha* Schauer subsp. *oligandra* (Turcz.)Toelken.

Introduction

Schauer(1844) distinguished seven species of *Kunzea* from Western Australia in the first volume on plants collected by Preiss, and described an eighth in the second volume (Schauer 1848). Bentham (1867) rearranged the species and placed most of them in his sect. *Eukunzea,* which largely agrees with the present sect. *Zeanuk* except that it is no longer considered to be the typical section of the genus, because, when *Kunzea* was conserved (Toelken 1981, 1981a), *K. capitata*, from eastern Australia, was selected as the type of the genus. Reichenbach (1828) in his original use of the genus *Kunzea* referred to three species. *Kunzea capitata* was selected as the type in preference to *K. ericifolia* and *K. corifolia* (now *K. ambigua*), because it has at all stages a capitate stigma, the distinguishing character used in the original publication. In the present circumscription of sect. *Zeanuk* all species are from Western Australia. Bentham's *K. muelleri* is excluded, although it shows a similar reduction of the placenta and number of ovules, because, in contrast to the western species, it has a well developed network of lateral veins in the leaves and does not shed the epidermis of its branches in a slough-like manner. A full discussion of the characteristics, their variation and affinities is included under each taxon.

The sect. *Zeanuk* is treated separately because it represents a large clearly demarcated group in the genus. The reduced venation of the leaves and the small placenta with decreasing numbers of ovules show that it is an advanced group when compared with some species of sect. *Kunzea.* As it consists of such a uniform group of species it was considered to be more informative to defer a general discussion of the morphology and generic concepts until the publication of the latter more heterogeneous section. The terminology of the inflorescences, i.e. the reduced conflorescence, the botryum, is used here as defined by Briggs & Johnson (1979). Attention is also drawn to the elongate late inflorescences sometimes observed, particularly in the subsections *Arborescentes* and *Globosae*, as they usually look quite different since their bracts enlarge and sometimes become almost leaf-like as for instance in *K. ciliata.* It is assumed that such a specimen of *K. recurva* was described as *K. spicata* (cf. typification of *K. recurva*). The bracts and bracteoles subtending each flower often vary in size relative to the flower in different plants of the same species, but their shape was found to be a reliable characteristic of each species. The lower bracts grade into the shape of the perules or scales surrounding the terminal perennating buds from which the inflorescence or vegetative shoot develops. These perules, below the botrya and usually caducous, are described to distinguish them from the bracts but they often differ from perules surrounding terminal vegetative buds.

The bark of kunzeas is not easily described although some types are very distinctive. 'Early bark' refers to that of young branches up to 1 cm in diameter as it is often observed on herbarium specimen. The bark on old stems often differs markedly. As soon as the epidermis has worn off an often distinctive bark develops, usually with vertical splits along the branches at an early stage. The solid ridges thus formed particularly in corky bark rarely show obvious transverse splits. In fibrous bark the ridges are much less distinct partly because they consist of membranous layers obtaining their fibrous texture by the decay of the soft cells in between and, partly because successive layers often split at different points. The third type of bark, not found in the Western Australian species, splits more regularly vertically and transversely, resulting in chartaceous pieces of rectangular to square shape which are shed in their entirety or as parts with straight cleavages. This tessellated pattern often grades into the fibrous one which in turn can show intermediates with the corky bark.

Keys are provided to the three subsections and in each of which there is a key to the species, subspecies and hybrids. Some species which could be mistaken as belonging to another subsection are included in both keys. For instance, *K. acuminata* and *K. similis* are included in the keys to both subsections *Globosae* and *Floridae*. Hybrids between species of different subsections have been included in both keys in order to draw attention to their existence.

The conservation status of individual taxa could not be fully evaluated since the available data were insufficient.

As it is not known how many of the duplicates of the types Schauer (1844) examined for descriptions of the species in Lehmann's compilation of the plants collected by Preiss, lectotypes have been selected. It was, however, found that he inscribed only one specimen of each collection cited, except in the case of *K. micrantha/K. micromera* where they represent different species (cf. typification of *K. micromera*). It is therefore highly likely that he had seen only the specimens he annotated and some of them should be holotypes, e.g. *K. pauciflora*, as at least some duplicates (=isotypes) had been distributed by then. Most types were examined for this study and the few that could not be located are marked 'n.v.'.

Putative hybrids

Hybrids between taxa were often observed and investigated in the field. Time was insufficient to attempt controlled artificial crossings. The shortcomings of morphological comparisons are realised; the object here is to create an awareness of the widespread existence of hybrids. Since they were largely found along disturbed road sides an increased occurrence must be expected with further interference with the vegetation.

Many, but not all possible hybrid combinations between taxa described here have been recorded. Some species do not grow near to one another. In other cases, for instance *K. affinis* and *K. jucunda*, although they often grow next to *K. micromera* and *K. recurva*, do not apparently cross with one another. Such cases of incompatibility seem to be rare as even these species hybridise with others in their own and other subsections. These individual cases do not seem to warrant studies of compatibility to obtain a wider understanding of relations. Pollen sterility was investigated in a few hybrids and was rarely found to exceed 10 to 20%, so it was not pursued as a means of identifying hybrids.

The many hybrids recorded show that the pollination mechanism(s) within sect. *Zeanuk* cannot be very selective as even pink-, white- or yellow-flowered species seem to cross easily. The flowers of different species are morphologically very similar, especially in the spacial arrangement of the floral parts, differing mainly in size.

The importance attributed here to hybrids might seem out of proportion to the numbers of plants found in a population if it were not that unusual plants, e.g. putative hybrids, are

often selectively collected. As early as the late 1840s J. Drummond collected and transmitted specimens of what seem to have been a hybrid between *K. montana* and *K. recurva*, which Turczaninov (1852) described as *K. squarrosa* (cf. 1(ii) *K. montana*).

That particular example shows the problem encountered with identifying hybrids and, closely linked to it, descriminating the species associated with them. Turczaninov based *K. squarrosa* on the pink-flowered (hybrid) form, while a yellow-flowered specimen, just mentioned at the end of the description, is now known to be one of the parental species, *K. montana*. Superficially the two specimens seem only to be colour forms of the same species. But this hybrid is an example in which a wide range of hybridisation with a complete range of backcrossing has resulted in forms so close to the original species that delimitation has become practically impossible. Without field studies of such a hybrid swarm it is impossible to distinguish between parent taxa and hybrids. A few such putative hybrid populations between different species were investigated, and the parents and the hybrids were eventually artificially delineated by what seems to be single character differences. It is purely a practical approach for localised situations which are at present rare.

This procedure was followed only where at least one large hybrid swarm with extensive backrossing was found. Most putative hybrids are incompletely known from a limited number of plants or even 'intermediate herbarium specimens' which can not be reconciled with known variation of the parental taxa involved. As more information on some of the hybrids becomes available similar artificial delimitations will have to be decided. In others the state of information is at present based on few records with limited backcrossing that they are sufficiently discrete to be individually recognised. Further field work may show some such disparate hybrids to be local forms, possibly even infraspecific taxa, of one of the putative parents (e.g. *K. micrantha* subsp. *oligandra* × *K. micromera* cf. 12c(i) for discussion). The intention here is to draw attention to the problems which field studies were too limited to resolve. Hybrids will, remain a problem in assessing herbarium material because:

1. the wide range of intermediates of a hybrid swarm resembles the range of intermediates between taxa.
2. isolated hybrids from two or more areas need not be similar to another with the same parents. Only in a hybrid swarm is the linking of all characters of the two parents achieved.
3. hybrids of perennial plants such as *Kunzea* can, at least theoretically, persist at a locality where one or both parents are no longer found. The alternative, that of long distance distribution of *Kunzea* seeds, is regarded as very unlikely. The sizes of populations of kunzeas were found to fluctuate extensively since they thrive in disturbed areas but soon get overgrown by the more permanent members of the vegetation of the area. Although most putative hybrids described here are based on field studies by the author, some specimens are cited from areas where one of the parents has not yet been recorded. Additional collecting to the original material seen has already redressed this in a few cases during the study.

With a full awareness of the problems, future collectors will be able to contribute to their clarification. Additional information of at present insufficiently known hybrids will soon render the keys provided useless. Nevertheless the mention of these hybrids in the keys will hopefully draw the user's attention to the discussion of hybrids, which are often far removed from the second taxon in the hybrid formula. The system of cross referencing and numbering, cumbersome though it is, avoids the repetition of discussions under each taxon.

KUNZEA sect. ZEANUK

Kunzea sect. **Zeanuk** Toelken, *sect. nov.*

Kunzea sect. *Eukunzea* Benth., Fl. Austr. 3: 112 (1867), nom. inval. partly, excl. *K. muelleri.*

A sectionibus aliis epidermide decorticanti opaca, foliis venis supralateralibus brevissimis, loculis ovarii (2–) 8–12 (–16) ovulis differt.

Type species: *K. glabrescens* Toelken.

Young branches with epidermis and cuticle soon becoming replaced and are resembling the slough of a snake. *Leaves* often with horny margins and usually without marginal cilia, with supralateral primary veins up to one-third of the leaf length and all veins free. *Calyx lobes* flat and appressed to buds (except in *K. ciliata*), not or scarcely ridged. *Ovary* with (2–) 5 locules, with small placenta with 2 more or less free lobes each with 1 or 2 rows of ovules which are spreading and smaller above, and/or pendulous and longer below; ovules (2–) 8–12 (–16) per locule.

Notes

Species of this section are restricted to south-western or rarely southern Western Australia. Bentham's sect. *Eukunzea*, which closely resembles this section, was based only on the low number of ovules, the most easily accessible characteristic of this section. It included for that reason *K. muelleri* from eastern Australia, and would now also need to incorporate the more recently described *K. cambagei.* That this similarity is a result of convergent evolution is shown by the characteristic leaf venation of the sect. *Zeanuk*, a character not easily observed in herbarium material. In contrast to this the other character typical of the sect. *Zeanuk* is the peculiar shedding of the epidermis as it becomes first opaque and then peels in large pieces. In all the eastern species the epidermis first splits longitudinally and then usually wears off as the bark develops, so that branches at no stage have an opaque outer layer as is typically found in sect. *Zeanuk.* These three characteristics are shown by the 21 Western Australian species grouped here in three subsections, but not by *K. baxteri* and *K. pulchella*, which also occur in that region.

Bentham's concept of sect. *Eukunzea* as being the typical section of *Kunzea* cannot be maintained since *K. capitata* was chosen, in preference to *K. ericifolia*, as lectotype of the genus *Kunzea* when it was conserved (Toelken 1981, 1981a). The epithet 'Zeanuk', an anagram of *Kunzea*, is used here for a section which now largely represents what Bentham considered to be true kunzeas.

Key to subsections

1. Petals and stamens yellow to cream; large shrubs or trees with few erect stems, (1.2–) 1.5–3 (–5) m tall; young bark usually pale yellowish-brown, smooth to slightly fluted, somewhat corky .... A. subsect. *Arborescentes*

1: Petals and stamens pink, purple or mauve, rarely white; shrubs with spreading to decumbent branches, 0.2–1.2 (–2.5) m tall; young bark grey, usually irregularly lacerated and more or less fluted, fibrous:

2. Inflorescences with (10–) 15–30 (–40) spreading flowers, with leaves below not clasping or only in lower third, mainly terminal on long shoots; stamens longer than petals .... B. subsect. *Globosae* (see p. 00)54

2: Inflorescences with (1–) 3–8 (–12) flowers more or less erect, with leaves below clasping at least two-third, terminal commonly on short shoots clustered below one on a long shoot (superconflorescence); stamens shorter, as long as, or sometimes just longer than petals .... C. subsect. *Floridae* (see p.oo)85

A. **Kunzea** subsect. **Arborescentes** Toelken, *subsect. nov.*

A subsectionibus aliis fruticibus elatis vel arboribus ad 6 m altis, floribus luteis vel cremeis differt.

Type species: K. glabrescens Toelken.

Large shrubs or trees (1.2–) 1.5–3 (–6) m tall, usually with few or rarely one stem, each with erect often almost virgate branches and without short shoots; bark on branches 5–15 mm diam. usually scarcely fluted and somewhat corky. *Leaves* linear to obovate and usually without distinct horny margin. *Inflorescence* with (12–) 18–30 (–38) flowers in globular heads, with vegetative growth after flowering from the terminal bud. *Petals* obovate to almost orbicular, shorter than stamens, yellow or cream.

Distribution and ecology

Species of subsect. *Arborescentes* are usually found in wet habitats along banks of rivers and lakes or seepage areas, rarely in winter-wet depressions. Only *K. montana* is found on upper slopes and then often in association with rock outcrops of the Stirling Range. Most of the species are locally common and occur mainly west of these mountains except for *K. ericifolia* which extends south-east to West Mount Barren.

Notes

The pale yellow flowers and arborescent habit may seem trivial characters to segregate these six species but they seem to form a natural grouping. Even *K. montana,* which had often been combined with *K. recurva* and which is here placed in subsect. *Globosae,* shows more similarities to *K. sulphurea* and was therefore placed in this subsection. *Kunzea montana*'s more robust habit and often unusually small plants must be attributed to its frequently more exposed habitat as at other times it becomes tree-like with erect branches, unlike *K. recurva* (compare also the shrub-like plants of *K. ericifolia* subsp. *subulata* on top of West Mount Barren). The confusion was probably caused by the early records of hybrids between the two species (cf. *J. Drummond 5, 136* and *137* in discussion of 2(ii) *K. squarrosa* under hybrids of *K. montana*), which then provided a complete range of intermediates similar to those now also recorded between *K. recurva* and *K. sulphurea.*

Young branches of plants of species of subsect. *Arborescentes* may at first appear to produce peeling fibrous bark, but this is usually only the peeling epidermis for the corky bark develops later.

The rate of growth in these species is generally so rapid that, at least on herbarium specimens, growth patterns can only be studied on specimens of senescent plants. Terminal vegetative growth above fruiting inflorescences, unless injured, is the usual pattern. In contrast to the *Floridae* all branches are long shoots and only exceptionally subterminal short shoots with inflorescences are produced in mature plants of especially *K. ericifolia.*

Key to species, subspecies and hybrids of subsect. *Arborescentes*

1. Petals pale to deeper pink (sometimes becoming pale in dried specimens):
   2. Calyx lobes with margins recurved .... 7. *K. recurva*
   2: Calyx lobes with margins incurved or spreading:
      3. Bracts with acute apex; young branches tomentose with coiled hairs:
         4. Branches wiry; leaves more or less ridged .... 13(ii). *K. micromera* × *K. montana*
         4: Branches rigid, spreading; leaves without ridges .... 1(ii). *K. montana* × *K. recurva*
      3: Bracts truncate to rounded; young branches glabrous or with few straight hairs:
         5. Bracteoles spathulate-obovate; leaf lamina broadly elliptic .... 6(ii). *K. clavata* × *K. recurva*
         5: Bracteoles sessile-obovate; leaf lamina obovate to broadly obovate .... 7(vii). *K. recurva* × *K. sulphurea*
         5: Bracteoles sessile obovate; leaf lamina oblong-oblanceolate..... 7(iii) *K. glabrescens* × *K. recurva*

1: Petals pale to deeper yellow:
   6. Leaf lamina flat, with rounded apex, elliptic, obovate to rarely almost orbicular:
      7. Bracts longer than 3.5 mm; young branches with coiled hairs .... 1. *K. montana*

7: Bracts up to 3 mm long; young branches glabrous or with short erect hairs:
   8. Young branches with short erect hairs; bracteoles obovate, glabrous .... 2. *K. sulphurea*
   8: Young branches glabrous; bracteoles obovate-spathulate, with scattered long hairs at the base .... 6(ii). *K. clavata* × *K. recurva*

6: Leaf lamina almost terete or club-shaped, or if compressed then with pointed apex:
   9. Bracteoles ovate to broadly ovate .... 3. *K. glabrescens*
   9: Bracteoles linear, linear-oblanceolate or -spathulate:
      10. Leaf lamina club-shaped, glabrous or with few scattered hairs; bracts truncate, rounded or rarely bluntly acute, if hairy then restricted to lower central vein:
         11: Young leaves and branches glabrous; bracts truncate or rounded and glabrous on lower flowers .... 6. *K. clavata*
         11: Young leaves and branches with few hairs; bracts bluntly acute or rounded and usually hairy on lower parts .... 6(i). *K. clavata* × *K. ericifolia* subsp. *ericifolia*
      10: Leaf lamina linear and more or less terete, or if broader then somewhat dorsiventrally compressed; bracts beaked or pointed, more or less covered with dense hairs:
         12. Leaves glabrous; bracteoles spathulate .... 5. *K. spathulata*
         12: Leaves more or less hairy; bracteoles linear to linear-oblanceolate:
            13. Young leaves hairy on both surfaces, somewhat dorsiventrally compressed or triangular in section; hairs on branches and leaves equally long .... 4a. *K. ericifolia* subsp. *ericifolia*
            13: Young leaves mainly hairy above, strongly convex below (to semicircular in section); hairs on branches often shorter and appressed .... 4b. *K. ericifolia* subsp. *subulata*

1. **K. montana** (Diels) Domin, Mém. Soc. Sci. Bohême (1921) 22, 2: 87 (1923); Blackall and Grieve, West. Austr. Wildflow. edn 2, 3A: 97 (1980).

Type: Western Australia, Stirling Range, *F. Mueller s.n.*, (*lecto.*—selected here: MEL 92674; B†; *possible isolecto.*: MEL 92775; *syn.*: Toolbrunnup, *F.L.E. Diels 4675* (B†, PERTH — fragment).

K. recurva var. *montana* Diels in Diels & E. Pritz., Bot. Jahrb. Syst. 35: 424 (1905); Blackall & Grieve, West. Austr. Wildflow. edn 1, 1: 293 (1954); Erickson et al. Flow. & Pl. West. Austr. 71, fig. 193 (1973).

K. squarrosa Turcz., Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Pétersbourg 10: 336 (1852), partly as for syntype: *J. Drummond 5, 136* — not as to lectotype.

K. recurva var. *recurva* auct. non Schauer: Benth., Fl. Austr. 3: 114 (1867), partly as for *J. Drummond 24 & 5, 136.*

Shrubs or sometimes trees with a short stem, up to 2 m tall, little- to much branched with lateral branches spreading to usually stiffly erect with terminal inflorescences; young branches often with distinct decurrent flanges, villous with long and short more or less twisted or coiled hairs but sometimes hairs restricted to area around leaf bases; early bark shallowly fissured, corky. *Leaves*: *petiole* (0.8–) 1–1.8 (–2.1) mm long, appressed in lower part; *lamina* orbicular, obovate to depressed obovate or rarely oblanceolate, (2.2–) 2.5–4.5 (–6.7) × (2.8–) 3.6–5 (–6.1) mm, rounded to truncate, but apex usually mucronate, cuneate to abruptly constricted into petiole, flat to more or less furrowed above, flat to somewhat convex below, spreading, becoming recurved at least in the upper third, glabrous. *Inflorescence* a spherical botryum with 18–32 (–38) flowers terminal on some branches, rarely clustered at the end of branches on short and long shoots, with terminal vegetative growth after flowering; *perules* usually 5 or more, depressed obovate, with rounded to truncate apex, usually with numerous veins (more than 10), glabrous or with few mainly marginal hairs, decidous; *bracts* broadly depressed-obovate to broadly obovate-spathulate, with the stalk as long as the broadened apex when subtending flowers of the upper parts of the inflorescence, 5.5–7 (–8) × 5–6 (–6.7) mm, rounded or rarely mucronate, with more than 10 veins if broad, to 3 in spathulate ones, glabrous rarely with few hairs towards the apex or at the base, or sometimes ciliate; *bracteoles* in pairs, linear-oblanceolate to oblanceolate-spathulate, 4.8–5.5 × 1.5–1.9 (–2.1) mm, truncate to rounded, tapering into a shorter or longer stalk-like base, 1 to few-veined, with hyaline margins, glabrous except for

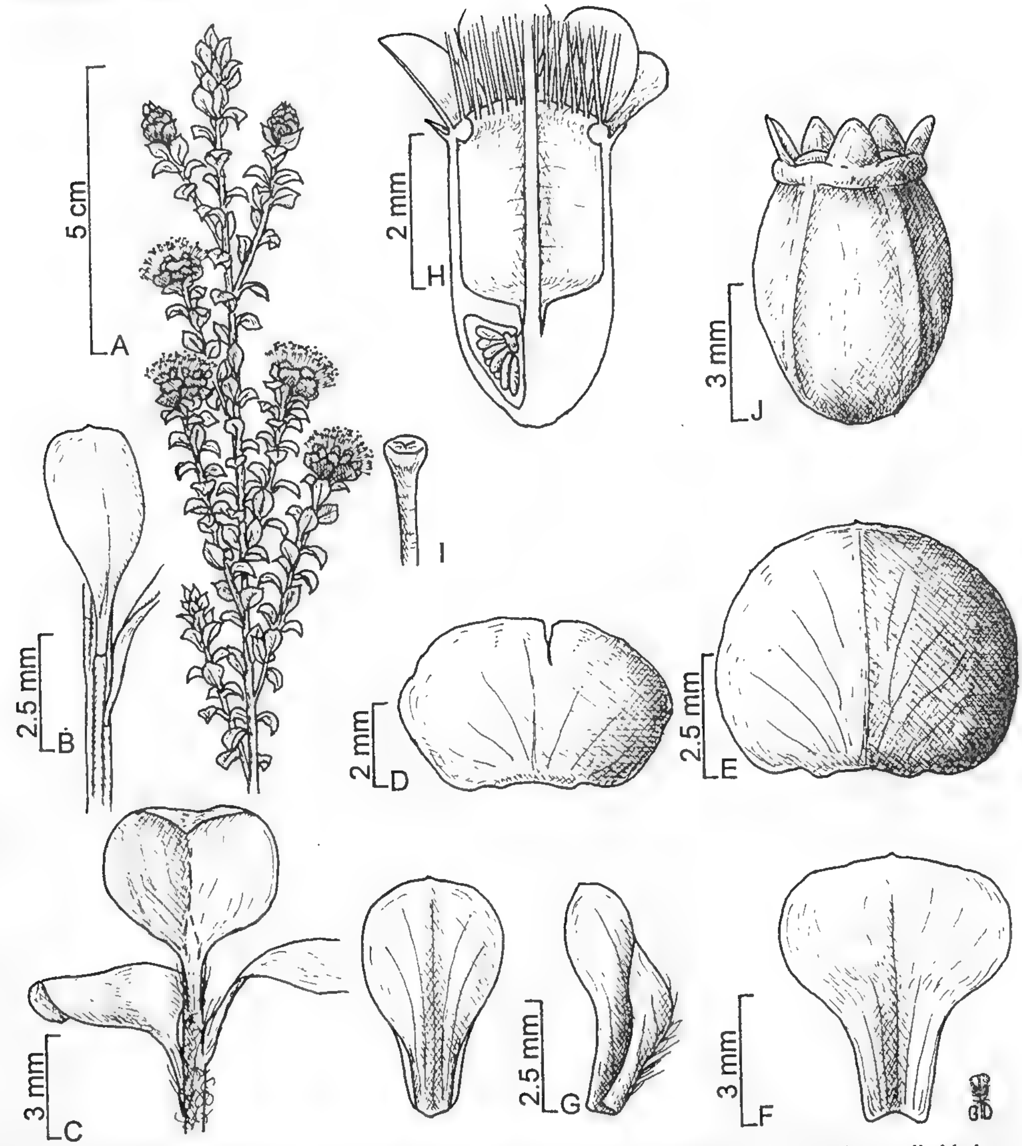
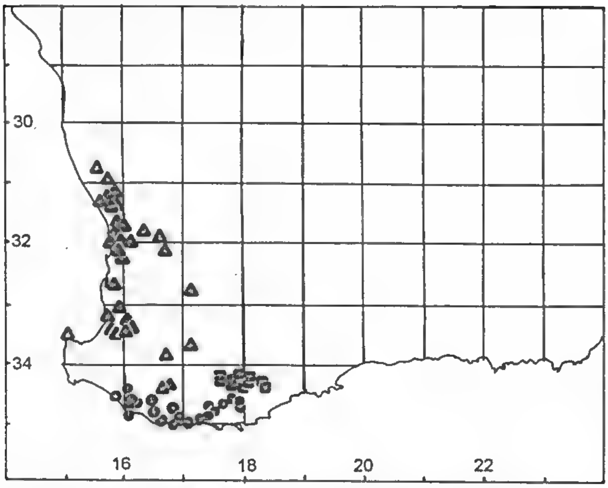


Fig. 1. ***K. montana*** (Diels)Domin. A, flowering branch; B, C, branchlet variation with or without coiled hairs, or with narrow or broad leaves; D, perule; E, lower bract; F, upper bract; G, bracteole; H, half flower; I, stigma; J, fruit. (A, B, D–I, *H.R. Toelken 7170*; C. *A. Morrison s.n.*, 13.x.1902; J, *J. Drummond MEL 92700*.)

long hairs along central ridge. *Hypanthium* 4.5–5.3 mm long when flowering (free tube ca 3 mm long), glabrous. *Calyx lobes* ovate, 0.7–1.1 mm long, rounded, often with hyaline margin, scarcely incurved, not ridged, glabrous. *Corolla lobes* obovate-orbicular, 2.2–2.5 mm long, sessile or scarcely clawed, cream to pale yellow. *Stamens* 50–67 in more than one whorl; filaments 4.2–5 mm long; anthers with dorsal gland scarcely protruding. *Ovary* with 5 locules, surmounted by a scarcely broadened style base sunk into the upper surface; placenta narrowly elliptic forming a scarcely fleshy disc with conical attachment connected to the upper third, with lobes connate mainly on the outside margins, each lobe with 1 to 2 rows of ovules; ovules 12–14 per locule, spreading except for two lowest longer pendulous ones; style 6.8–7.5 mm, scarcely broadened towards the base; stigma scarcely broader than style with shallow central depression. *Fruit* an elongate urceolate capsule usually slightly constricted below the erect calyx lobes. *Flowers:* October, November. *Common name:* mountain kunzea (Erickson et al. 1973, Blackall & Grieve 1980). Fig.1.

Distribution and ecology



Map 1. *K. montana* ◘; *K. sulphurea* ○; *K. glabrescens* ▲.

Known only from the Stirling Range where it grows on rocky slopes or associated with rock outcrops often below rock faces. Map 1.

Conservation status

Rare but all populations are conserved in Stirling Range National Park.

Diagnostic features

The species could be confused with *K. sulphurea* because of the yellow flowers and very broad bracts, but is distinguished by its hypanthium being almost twice as long, broader leaves and spathulate bracts that subtend the upper flowers.

Variation

Specimens of *K. montana* show considerable variation in size and shape of leaves and in tomentum as well as in the more or less pronounced flanges on the branches. Some of this variation is local, as, for instance, a form with particularly broad leaves which are abruptly constricted towards the base that has been recorded from Red Gum Pass. Since plants are usually restricted to rock outcrops or rock faces, populations are often isolated. However, until a full range of variation of each population has been recorded such local variation cannot be fully evaluated.

Typification

The sheets of two syntypes in B were destroyed. A fragment of *F.L.E. Diels 4675* exists in PERTH. Another small specimen from the Blackall collection bears no number or other means by which it can be recognised as a type except from an annotation that it was collected by Diels. The leaves are narrower than 4–5 mm as described by Diels, but then they are not much broader in the PERTH specimen except that leaves below the inflorescence tend to be narrower. The specimen *Mueller s.n.* MEL 92674 was selected as the lectotype because it is accompanied by the field label. MEL 92775 is a possible duplicate.

Specimens examined

WESTERN AUSTRALIA: *T.E.H. Aplin 2088*, Mt Toolbrunup, 17.x.1962 (PERTH); *A.M. Ashby 585*, towards Toolbrunup, 5.x.1963 (AD); *J.S. Beard 7446*, Toolbrunup, 25.ix.1975 (NSW); *7604*, Talynberlup, 30.ix.1975 (NSW); *B.G. Briggs NSW 124060*, Red Gum Pass, 10.x.1960 (NSW); *E.M. Canning CBG 34182*, Bluff Knoll, 24.x.1968 (CBG); *CBG 34183*, Bluff Knoll, 24.x.1968 (CBG); *CBG 34414*, 12.8 miles from Chester Pass Road, 23.x.1968 (CBG); *CBG 45970*, Mt Hamilton, 9.x.1968 (CBG); *F.L.E. Diels s.n.*, Stirling Range, s.d. (PERTH); *A.A. Dorrien-Smith s.n.*, Warrunup Hill, Stirling Range, -.-.1910 (K); *J. Drummond 24*, W. Australia, s.d. (MEL 92677); *J. Drummond 5, 136*, W. Australia, 1849 (BM, K, NSW); *J. Drummond MEL 92700*, W. Australia, s.d. (MEL); *R. Edmiston 776*, Stirling Range, 9.vii.1974 (PERTH); *A.R. Fairall 466*, above Red Gum Springs, 9.x.1962 (KPBG, PERTH); *J. Forrest MEL 92724*, Stirling Range, xi.1934 (PERTH); *A.S. George 10430*, The Arrows, 11.x.1970 (PERTH); *A.S. George s.n.*, Bluff Knoll, 12.xi.1961 (PERTH); *R. Hill AD 966041738*, Stirling Range, ix.1953 (AD); *R. Hill & R. Jordan AD 966081036*, Ross Peak, ix.1953 (AD); *A. Morrison s.n.*, Red Gum Pass, 13.x.1902 (K, PERTH); *E. Mullins 376*, Bluff Knoll, 6.i.1978 (CBG); *K. Newbey 1455*, Mt Warrungup, 6.ix.1964 (PERTH); *M.E. Phillips CBG 10061*, above Red Gum Springs, 9.x.1962 (CANB, CBG); *R.D. Royce 6055*, Bluff Knoll, 27.x.1959 (PERTH); *B. Sachse CBG 32891*, track up Mt Toolbrunup, 27.x.1968 (CBG); *H.*

Steedman 14, Stirling Range, i.1932 (PERTH); *A. Strid 21564*, Bluff Knoll, 25.xi.1982 (K, PERTH); *H.R. Toelken 7170*, Bluff Knoll, 1.xi.1981 (AD, PERTH); *J.W. Wrigley CBG 028472*, Mt Hamilton, 9.x.1968 (BRI, CBG).

Putative hybrids

1(i) *K. micromera* × *K. montana* see 13(ii) *K. micromera*

1(ii) ***K. montana* × *K. recurva***

K. squarrosa Turcz., Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Pétersbourg 10: 336 (1852), pro species.

Type: Western Australia, *J. Drummond 5, 137* (*lecto.* selected here: KW—photo in PERTH!; *isolecto.*: BM, K, MEL 92676; *syn.*: excl. *J. Drummond 5, 136* BM, NSW—now identified as *C. montana*).

The rigid and robust habit, the villous tomentum with short coiled hairs, and the absence of recurved margins of calyx lobes are characters of *K. montana*. The broad, short petiole (0.6–1 mm long), the strongly recurved leaf lamina, the narrower inconspicuous bracts (3.2–3.5 (–5) mm broad), which are acute or bluntly acute and shorter than the flower buds, as well as the pink petals suggest that *K. recurva* is the second parent.

Typification

K. squarrosa Turcz. (1852), the first name for the species complex, must be rejected as it is based on a hybrid. The author stated unambiguously in the diagnosis to the protologue that the pink-flowered syntype (*Drummond 5, 137*), i.e. the hybrid, is the typical one and the other one with white (pale yellow?) flowers is cited as an additional specimen. A lectotype was chosen accordingly from a number of duplicates of *Drummond 5, 137*, while *Drummond 5, 136* with white (pale yellow?) flowers and longer and larger bracts must be identified as typical *K. montana* and excluded from this taxon. A specimen of *Drummond 5, 137* (K) must also be identified as *K. montana*.

Specimens examined

WESTERN AUSTRALIA: *J. Drummond 5, 137*, s.loc., 1849 (MEL); *J.W. Wrigley CBG 26964*, above Red Gum Springs, 10.x.1968 (CBG, BRI).

2. **K. sulphurea** Tovey & P. Morris in Proc. Roy. Soc. Victoria n.s. 35: 194 (1923).

Type: Western Australia, Big Brook near Pemberton, *M. Koch 2539*, (*lecto.*—selected here: MEL 92310; *syn.*: *M. Koch 2539* (BM, MEL 92311, 92312, 92313, 92315); *possible isosyn.*: *M. Koch 2539* (K, NSW, PERTH).

Shrubs or small trees 1.7–3.5 (–6) m tall, with few stems stiffly erect and with thin and wiry lateral branches, much branched; young branches with decurrent flanges slightly raised, usually densely covered with very short erect hairs; early bark fibrous-mosaic becoming thinly corky, very shallowly fluted. *Leaves*: *petiole* (0.2–) 0.3–0.5 (–0.6) mm long, appressed; *lamina* oblanceolate, rarely elliptic-oblanceolate, (2.8–) 3–3.4 × (1–) 1.4–2.5 mm, bluntly acute to rounded, gradually constricted into petiole, usually flat above, below slightly convex or ridged and with subterminal blunt point, spreading becoming sometimes recurved later, glabrous or rarely with very short hairs on the lower parts of the leaves. *Inflorescence* a spherical botryum with (12–) 15–19 (–23) flowers, terminal mainly on lateral branches and usually not clustered, rarely with terminal vegetative growth after flowering; *perules* few to usually more than 5, broadly ovate to depressed ovate, with rounded apex, with numerous but usually indistinct veins, with hyaline margin and often with marginal cilia; *bracts* broadly obovate to obovate-spathulate towards the apex of the

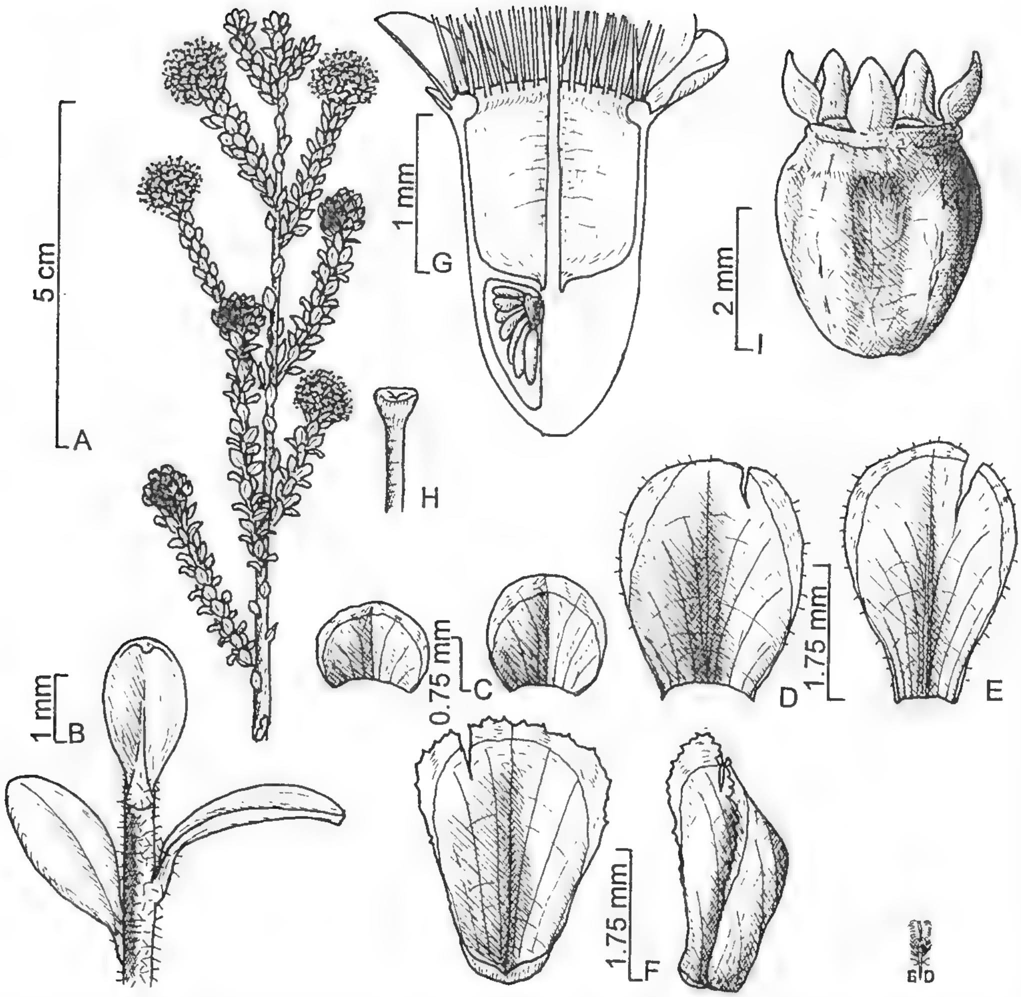


Fig. 2. *K. sulphurea* Tovey & P.Morris. A, flowering branch; B, branchlet showing spreading trichomes; C, perules; D, lower bract; E upper bract; F, bracteole; G, half flower; H, stigma; I, fruit. (A–H, *M.E. Phillips CBG 22621* (NSW); I, *M. Koch 2539* (MEL).)

inflorescence, rarely oblong, (1.6–) 2–2.3 × (1.3–) 1.5–2.4 mm, rounded or rarely bluntly acute, with several veins from the base but often indistinct, glabrous except for sometimes a few cilia on lower third or rarely with few hairs on the base of the abaxial surface; *bracteoles* in pairs, oblong-obovate to rarely oblanceolate, (1.8–) 2–2.2 × 1.3–1.7 (–2) mm, rounded and more or less hooded but often split, hyaline except for central ridge, glabrous or rarely with a few hairs towards the base of the abaxial surface. *Hypanthium* 2.6–2.8 mm long when flowering (free tube ca 1.4 mm), glabrous. *Calyx lobes* ovate-triangular, 0.7–1 mm long, rounded, with hyaline margins somewhat incurved, not ridged, glabrous. *Corolla lobes* obovate-orbicular, 1.4–1.7 mm long, scarcely clawed, pale yellow. *Stamens* 29–42 (–50) in more than one whorl; filaments 3.2–3.8 mm long; anthers with dorsal gland broad but not much protruding. *Ovary* with 5 locules, surmounted by a style base slightly sunk into the upper surface; placenta narrowly elliptic, a scarcely fleshy disc with conical attachment connected to the upper third, with lobes connate mainly on the outside margins, each lobe with one row of ovules; ovules 6–8 per locule, spreading except for two lowest longer pendulous ones; style 3.9–4.6 mm long, slightly broadened towards the base; stigma scarcely broader than style and with central depression. *Fruit* an urn-shaped capsule with

vertically bulging ridges alternating with the erect clasping calyx lobes. *Flowers*: (September) October, November. Fig. 2.

Distribution and ecology

Growing usually in sandy soil in swampy areas or along streams often associated with forested areas from near Pemberton in a belt along the coast to near Mt Barker and Porongurup (excluding the area between Denmark and Albany). Map 1.

Conservation status

Often common along swampy areas in Sir James Mitchell National Park but also in other parks.

Diagnostic features

This distinct species has commonly been ignored and specimens identified as either *K. montana*, *K. recurva* or even *K. ericifolia*. *K. sulphurea* is superficially similar to *K. montana* but may be distinguished by its very short erect hairs on the branches, smaller flowers and more delicate bracts. The much less robust plant but yet a tall shrub or tree as compared with *K. montana* is easily distinguished from *K. recurva* by its broad rounded bracts and bracteoles and yellow flowers. The oblanceolate leaves and rounded bracts and bracteoles distinguish it from *K. ericifolia*. The specific epithet is somewhat misleading as flowers are pale yellow and have never been recorded as sulphur yellow.

Variation

Some local variation in the shape of the bracts has been observed:

1. Specimens from the area between Denmark and Walpole and apparently up to the Shannon River have broad, obovate-spathulate bracts with a rounded to almost truncate apex which are as long or longer than the hypanthium.
2. West of the Shannon River and in particular near Pemberton and Northcliffe the bracts tend to be oblong-oblanceolate and often only half as long as the hypanthium. Their apex is usually bluntly acute to acute. The fact that specimens from between Northcliffe and Windy Harbour often have hairs on the abaxial surface of the bracts (e.g. *Ashby 2702*, a collection which includes hybrids) could indicate that the material determined as this species includes a series of introgressive hybrids with *K. recurva*, as the latter species usually has hairs on the basal abaxial surface and so has the putative hybrid between the two species (cf. *K. recurva*).
3. Similarly collections from near Mt Barker and eastwards to the Porongorup Range have obovate-spathulate bracts with a bluntly acute to almost acute apex at least on the upper flowers of an inflorescence, and tend to be shorter than the hypanthium. Since some of the specimens have hairs on the basal abaxial surface of the bracts, e.g. *Wittwer 279* (S Mt Barker), it is tempting to ascribe this phenomenon to an introgressional range of hybridisation. However, although *K. recurva* has been recorded from near that area no hybrids have been recorded.

Typification

Koch re-collected the species several times under the same number *2539*. Eight sheets were examined but none bore the crucial date "Nov. 1920" cited in the protologue. Since it has not been documented that this is in error for 1921, which is probably the correct date judging by the sequence of events (cf. specimens listed below), a holotype could not be determined. There is, however, some evidence that the specimens on six of the sheets were

seen by at least one of the authors before 1923, when the name was published. It is therefore proposed to treat all the following specimens as syntypes, and a lectotype has been selected from them. The status of two more sheets with the same collector's number, i.e. possible isotypes of the lectotype in NSW and PERTH, cannot be clearly assessed. Since the name *'K. sulphurea'* is written in what seems to be Koch's handwriting, it is assumed here that they were distributed by the collector without the authors having seen them and probably after publication. No information could be obtained on whether they are in fact even later collections or whether they are duplicates of earlier collections.

1) MEL 92311 "1.1921/ a shrub 2 to 4 m high/ in sandy places" in Koch's hand (fruiting).
2) BM s.n. "Jan. 1921" A Melbourne Herbarium label, not in Koch's hand. added "comm. 1922" in S. Moore's hand. (fruiting and flowering).
3) MEL 92312 (sheet 1 of 2) no date/ "shrub 2 to 6 m high" in Koch's hand (flowering; precursor manuscript description attached).
4) MEL 92313 (sheet 2 of 2), like 3 but nothing attached.
5) MEL 92310 (sheet 1 of 2) "fl: Nov 1921/ fr: January 1921/ a shrub up to 18 feet high/ almost arborescent" on original label and on field note" 2539/ 21 Nov 1921" in Koch's hand (flowering and fruiting; S. Moore's reply attached).
6) MEL 92315 (sheet 2 of 2). Label as in 5 but different field note possibly in Koch's hand "fruiting specimens/ 2539/ Kunzea/ 1.1922" (flowering and fruiting).

The selection of a lectotype must be guided by (i) only flowering specimens are described in the Latin diagnosis, and (ii) the phrase "almost arborescent ... shrub up to 18 feet high" in the protologue. The combination of these two statements apply only to sheets 5 and 6, but 6 is discarded in preference to 5 because its flowering specimen has only a few intact flowers. The flowering specimen on the lower right of sheet 5 (MEL 92310 which contains also a fruiting specimen) being attached to a label in the collector's hand "2539 21 Nov 1921" and also being the most complete specimen on that sheet, is selected as the lectotype.

In the selection process not much weight was given to documents now attached to some of the sheets, because they were only recently mounted and, for instance, S. Moore's reply concerning the identification of the specimen was added later, as inscribed. The specimen at BM (2) must be regarded as a syntype because it was part of the collections examined by the authors of this species before it had been sent there for confirmation. S. Moore in his reply (Sept. 1922) encouraged the authors to describe the taxon. The description is included in a paper read before the Royal Society of Victoria on 14th December, 1922. The specimen at K is probably a duplicate sent there from MEL after the name was published as it combines information of 2 and 3.

Specimens examined (68 seen)

WESTERN AUSTRALIA: *A.M. Ashby 2702*, near Windy Harbour, 22.x.1968 (AD, MEL, PERTH); *J.S. Beard 5775*, between Pemberton and Northcliffe, 2.xi.1968 (KPBG, PERTH); *7692*, S Mt Barrow, Mt Barker, 16.x.1975 (NSW); *R.J. Cranfield 4909*, NW edge of Lake Maringup, 13.xii.1983 (PERTH); *H. Eichler 16123*, Walpole, 2.ix.1959 (AD); *L. Fell 34*, between Chudalup & Cape D'Entrecasteaux, 3.xi.1968 (KPBG); *C.H. Gittins 1760*, Bow River, ix.1967 (BRI); *J.W. Green 1121*, ca 5 miles SW Walpole, 3.xii.1956 (PERTH); *T.A. Halliday 269*, Naenup swamp, 10.xii.1974 (AD); *S.W. Jackson s.n.*, Bow River, between Irwin's and Brooke's Inlets, xi.1912 (CANB, NSW, PERTH); *M. Koch 2539*, Pemberton, i.1921 (BM, K, MEL, NSW, PERTH); *J.H. Maiden NSW 124054*, Porongorup, xi.1909 (BRI, NSW); *F. Mueller MEL 92827*, Swampy banks of the Shannon, 12.xii.1877 (MEL); *K. Newbey 1506*, east-end of Porongorup Range, 12.xi.1964 (PERTH); *M.E. Phillips CBG 13226*, near Northcliffe, 20.x.1962 (BRI); *CBG 19312*, 11 miles from Denmark to Manjimup, 12.x.1962 (CBG); *CBG 22621*, near Walpole, 12.x.1962 (CBG); *A.N. Rodd 49498 & G. Fenson*, 5 km E Kent River, 12.xi.1985 (PERTH); *F.M.C. Schock 70*, Warren River, 19.x.1916 (PERTH); *J.A. Thomson s.n.*, Denmark 24.x.1939 (PERTH); *H.R. Toelken 6445*, 72 km NW Walpole, 5.x.1979 (AD, PERTH); *6447*, 44 km NW Walpole, 5.x.1979 (AD, PERTH); *6449*, 10 km NW Bow River bridge, 6.x.1979 (AD, PERTH); *6451*, 2.3 km E Bow River bridge,

6.x.1979 (AD, PERTH); *7177*, 16 km S of turnoff from Mt Barker Manjimup road along road to Denmark, 2.xi.1981 (AD, PERTH); *7179*, 15 km W Denmark, 2.xi.1981 (AD, PERTH); *H.R. Toelken 7180*, 19 km W Denmark, 2.xi.1981 (AD, PERTH); *7900*, 10 km S from Manjimup – Mt Barker Road on road to Denmark, 26.ix.1988 (AD, PERTH); *J.H. Willis MEL 92678*, 15 miles from Walpole to Pemberton, 6.ix.1947 (MEL); *E. Wittwer 279*, South Mt Barker, 27.ix.1963 (KPBG, PERTH); *J.W. Wrigley CBG 30395*, 6 miles from Denmark to Mt Barker, 13.x.1968 (AD).

Putative hybrids

2(i) *K. recurva* × *K. sulphurea* see 7(vi) *K. recurva*

3. **K. glabrescens** Toelken, *sp. nov.*

K. ericifolia (Sm.)Rchb. ex Heynh. var. *glabrior* Benth., Fl. Austr. 3: 113 (1867); Domin, Mém. Soc. Sci. Bohême (1921) 22, 2: 86 (1923).

Type: Western Australia, Swan River, *J.A.L. Preiss 271* (*lecto.* — selected here: K ; *isolecto.*: LD, W; *syn.*: Gordon River, *G. Maxwell s.n.*, and excluding type of *K. propinqua*, see under *K. ericifolia*.

K. propinqua auct. non (Endl.)Schauer: Schauer in Lehm., Pl. Preiss. 1: 126 (1844) as for *J.A.L. Preiss 271*.

K. ericifolia auctt. non (Sm.)Rchb. ex Heynh.: Blackall & Grieve, West. Austr. Wildflow. edn 1, 1: 293 (1954), partly; Rye in N.G. Marchant et al., Fl. Perth Region 1: 410 (1987), partly, as for specimens from the Perth area.

K. vestita auctt. non Schauer: A.D. Chapm., Contrib. Herb. Australiense 18: 2 (1976), partly; Blackall & Grieve, West. Austr. Wildflow. edn 2, 3A: 98 (1984), partly, as for specimens from the Perth area.

K. ericifoliae similis sed bracteis et bracteolis sessilibus late obovatis obtusis vel subtruncatis brevioribus quam hypanthiis differt.

Type: Western Australia: Greenwood, S Lake Goolelal, *H.R. Toelken 7103* (holo.: AD; *iso.*: B, K, MO, PERTH).

Large shrubs rarely up to 4 m tall, with several much branched erect stems and erect branches; young branches with flanges slightly raised, with few to many short and long hairs usually somewhat appressed, often coiled, glabrescent rarely glabrous; early bark fibrous-mosaic, becoming slightly corky and very shallowly fluted. *Leaves*: *petiole* up to 1 mm long, appressed; *lamina* linear-oblanceolate to linear or sometimes linear-subulate (4–) 5–8 (–10) × 0.5–1 (–1.5) mm, bluntly acute or rounded, rarely acute, more or less gradually constricted into petiole, flat to slightly concave above, usually distinctly convex below to almost triangular, rarely flat on both surfaces and with slightly depressed central vein below and then usually linear-lanceolate, straight, erect to spreading or recurved when older, with few to many hairs but soon glabrescent. *Inflorescence* a spherical to slightly elongate botryum with 18-28 flowers, terminal on long shoots, rarely with vegetative growth after flowering; *perules* usually more than 5, deciduous, ovate, bluntly acute and often mucronate, with a number of radiating branched veins from the base, with short hairs at the abaxial base and/or apex becoming often almost glabrous; *bracts* ovate to usually angular obovate, 1.8–3.2 × 1.2–2.3 mm, bluntly acute or acute, with 3 veins, with few short hairs at the abaxial base or sometimes with marginal cilia; *bracteoles* in pairs, broadly ovate to depressed ovate, 1.9–2.2 × 2.8–3.1 mm, rounded or truncate rarely emarginate, with 3-5 main veins, with few short hairs at the abaxial base. *Hypanthium* 3–4 mm long when flowering (free tube 1.2–1.6 mm), usually longer than bracts, glabrous, often distinctly ridged along the veins. *Calyx lobes* ovate-triangular, 1–1.8 mm long, acute to bluntly acute, more or less ridged, glabrous. *Corolla lobes* obovate to orbicular, 1.2–2.1 mm long, to rarely clawed, pale yellow. *Stamens* 30–45 (–60) in more than one whorl; filaments 2.4–2.7 mm long; anther with scarcely developed subterminal gland. *Ovary* 5-celled, with style slightly sunk into the upper surface; placenta a narrowly elliptic fleshy disc with short attachment on upper third, 2-lobed and fused on outer margin, each lobe with 1 row of ovules; ovules 8–12 (–15) per locule in lower flowers, 6–8 in upper ones, spreading or lowest 2–4 pendulous and slightly longer; style 4.2–4.6 mm long, with disc-like terminal stigma. *Fruit* an urn-shaped capsule with locules bulging and calyx lobes spreading to

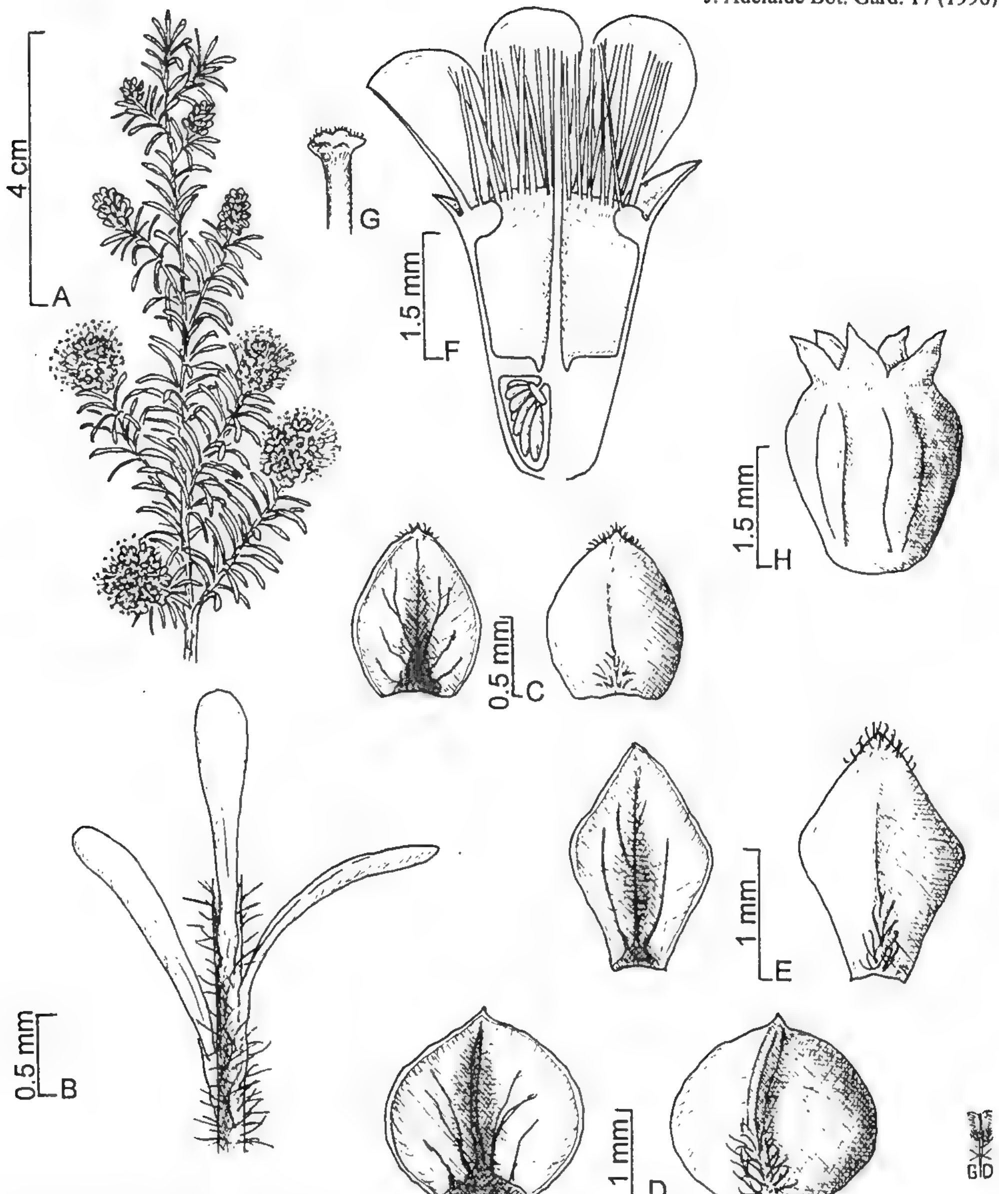


Fig. 3. ***K. glabrescens*** Toelken. A, flowering branch; B, branchlet showing spreading hairs; C, perule; D, bract; E, bracteole; F, half flower; G, stigma; H, fruit. (A–G, *H.R. Toelken 7103*; H, *F. Stoward 142*.)

recurved. *Flowers:* (September) October, November. *Common name*: spear-wood (Rye in Marchant et al. 1987). Fig. 3.

Distribution and ecology

Growing usually on sandy soil on edge of swamps, lakes, rivers or in depressions temporarily flooded. Locally common near Perth but also recorded from near Picton Junction, Cape Naturaliste and on the Gorden River and Lake Muir near Cranbrook. Map 1.

Conservation status

Although apparently widespread its main population in and around the urban spread of Perth and Freemantle need to be monitored.

Diagnostic features

K. glabrescens is similar to and has often been confused with *K. ericifolia*, but is distinguished from all other species with linear leaves and yellow flowers by its very broadly ovate, sessile bracteoles.

Variation

The normally broad bracts are frequently somewhat elongated especially on late inflorescences but they are usually leaf-like so that they should not be confused with the acuminate ones of *K. ericifolia*. The bracts are more or less covered with short hairs unlike bracts and bracteoles of normal inflorescences where usually only a few short hairs occur on the abaxial base.

The tomentum on the leaves shows considerable variation but mature leaves are generally glabrous.

This species which is often common around wet areas in the vicinity of Perth has been recorded from three localities some distance from the main population. They differ only in minor detail.

Typification

Bentham's (1867) description of *K. ericifolia* var. *glabrior* as generally less villous and sometimes nearly glabrous compared with typical *K. ericifolia*, fits *J.A.L. Preiss 271* (K) well, which is selected as the lectotype in preference of *G. Maxwell s.n.*, which represents a slightly unusual population of the species.

Etymology: The epithet 'glabrescens' (= becoming glabrous, Lat.) was preferred to Bentham's var. *glabrior.*

Selection of specimens examined (ca 85 seen)

WESTERN AUSTRALIA: *W.H. Atkins 68*, 194 m Albany Highway, iii.1952 (PERTH); *N. Byrnes 3969*, 16 km W Gingin, 1.x.1980 (BRI); *N. Byrnes 3981*, 30 km N Gingin, 2.x.1980 (BRI); *J.S. Beard 8205*, 16 km N Kojonup on Albany Highway, 26.x.1977 (PERTH); *W.E. Blackall 2955*, Gingin, 1.x.1932 (PERTH); *M.L. Cambridge s.n.*, Leschenault Inlet, 6.xii.1971 (PERTH); *E.M. Canning CBG 31515*, near Medina along Baldivis Road, 3.x.1968 (CBG, CANB); *F.L.E. Diel & E. Pritzel 248*, Picton Junction, xii.1900 (K, PERTH); *J. Drummond 1, 131*, s.loc., -.1843 (BM, K, NSW, W); *J.L. Francis s.n.*, Popanyinning, 1982 (AD); *R. Helms s.n.*, Guildford, 15.x.1897 (PERTH); *R. Helms NSW 124017*, Cannington, 2/9.i.1899 (NSW); *M. Koch 1768*, Onlina River near Wooroloo, xi.1907 (AD, K, MEL, NSW, W); *2647*, Picton Junction, 25.xii.1922 (MEL, NSW, PERTH); *T.R. Lally 46*, Jandakot Airport, s.d. (AD, CANB, CHR, LAE, MEL, MO, PERTH); *Mrs McHard MEL 92803*, Blackwood River, 1853 (MEL); *J.H. Maiden NSW 124024*, Welshpool to Kalamunda, ix–x.1909 (NSW); *NSW 124025, NSW 124022*, Cape Naturaliste, x.1909 (BRI, K, NSW); *F. Mueller MEL 92854, MEL 92741*, between Preston and Collies River, xii.1877 & 7.xii.1877 (MEL); *G. Maxwell MEL 92527*, Gordon River, s.d. (MEL); *Oldfield MEL 92835*, Lake Muir, Blackwood to KGS, s.d. (MEL); *C.H. Ostenfeld 1316*, Kings Park, 1914 (PERTH); *M.E. Phillips 1781*, 8 mls from Gingin to Regans Ford, 28.ix.1968 (CBG, CANB); *J. Pocock AD 96923626*, Harvey, 30.x.1968 (AD); *Preiss 271*, Perth, xi.1839 (W); *R.A. Saffrey 1767*, Blue Waters, Collie, 1.xi.1979 (PERTH); *J. Sanster 592*, Bilbra, 17.xi.1946 (K); *B.H. Sargent 1035*, Talbot Brook, 1.xi.1914 (NSW); *F. Stoward NSW 124015*, Kulikup, iii.1916 (NSW); *A. Strid 21626*, 26 km Kojonup to William, 27.xi.1982 (K); *H.R. Toelken 7898*, N.E. Lake Muir, 26.ix.1988 (AD, PERTH).

Putative hybrids

3(i) ***K. glabrescens* × *K. recurva***

The specimen has mainly fine long hairs on young internodes and leaves and broadly ovate bracts and bracteoles which resemble those of *K. glabrescens*. However, the large flowers with pink petals (pale mauve) and the long hairs on the bracts and bracteoles could only have been derived from *K. recurva* in that area. The flat linear-elliptic leaves are distinctly recurved. Although only one specimen was examined its characters, which are

intermediate between the two species, would suggest this hybrid in spite of it being recorded 'locally common'.

Specimen examined

WESTERN AUSTRALIA: *R.W. Purdie 4068*, Kojonup - Frankland road, 38.7 km S from Frankland road turnoff at Kojonup end, 9.xi.1990 (CBG).

4. **K. ericifolia** (Sm.) Rchb. ex Heynh., Nom. Bot. Hort. Dresden edn 1, 1: 337 (1840), as 'ericaefolia'; Benth., Fl. Austr. 3: 113 (1867).

Type: Western Australia, King George Sound, *A. Menzies s.n.* (*holo.*: LINN-S, microfiche!).

Metrosideros ericifolia Sm. in Rees, Cycl. 23: No. 16 (1813).

Shrubs up to 3 m tall, with one to few erect stems and lateral branches ascending to spreading; young branches with flanges more or less raised, villous with usually only long hairs, rarely with long and short ones, hairs usually straight and spreading but becoming somewhat appressed with age; early bark fibrous-mosaic becoming elongate-mosaic and slightly corky but usually flaking. *Leaves*: *petiole* 0.5–1.5 mm long and appressed; *lamina* linear-lanceolate to linear-elliptic, (28–) 34–63 (–82) × (0.5–) 0.6–1 mm, with pointed pale apex, gradually though slightly constricted into the petiole, flat to somewhat concave above, flat to slightly but rarely strongly convex below, with pointed pale apex, with central vein rarely visible at the base, spreading and strongly recurved when old, rarely erect, more or less covered with long spreading hairs rarely becoming glabrous. *Inflorescence* a more or less spherical botryum with 20–35 spreading flowers terminal on but rarely clustered at the end of branches, rarely with terminal vegetative growth after flowering; *perules* usually more than five, deciduous, similar to basal bracts and often pointed with leaf-like projection or leaves with basal membranes, with many veins from the base, usually covered with long hairs; *bracts* ovate on lower part of inflorescence to spathulate above, 4–6 × 2.3–3.2 mm, with 3–6 main veins, acuminate to rostrate, with long spreading hairs all over except for beak and lower margins; *bracteoles* in pairs, linear-falcate to narrowly oblanceolate-falcate, 3.2–4.4 × 0.25–0.46 mm, with one central vein with scarcely membranous margins, pointed, covered with long spreading hairs. *Hypanthium* 3–4.5 mm long, when flowering (free tube 1.3–1.6 mm), usually shorter than bracts, veins usually not distinct, glabrous. *Calyx lobes* triangular, 1–1.8 mm long, usually acute, sometimes ridged towards the apex, glabrous. *Corolla lobes* obovate-orbicular to broadly spathulate, 1.6–2.1 mm long, pale yellow to greenish-yellow. *Stamens* 35–46 in more than one whorl; filaments 3.2–3.8 mm long; anthers with small subterminal gland. *Ovary* 5-celled, with style slightly sunk into the upper surface; placenta a narrow-elliptic fleshy disc with attachment on upper third, 2-lobed, fused mainly on outer margin, each lobe with one row of ovules; ovules (6–) 8–10 (–12), upper ones short and spreading, lowest 4 longer and pendulous; style to 8 mm long, broadened towards the base, with disc-like stigma about twice the diameter of style below. *Fruit* an urn-shaped capsule with locules more or less bulging and calyx lobes erect.

4a. subsp. **ericifolia**.

Metrosideros ericifolia Sm. in Rees, Cycl. 23: No. 16 (1813); DC., Prodr. 3: 225 (1828); Steud., Nomencl. Bot. 2 edn, 2: 137 (1841).

K. ericifolia (Sm.)Rchb. ex Heynh., Nom. Bot. Hort. Dresden edn 1, 1: 337 (1840) as 'ericaefolia'; Benth., Fl. Austr. 3: 113 (1867); Domin, Mém. Soc. Sc. Bohême (1921) 22, 2: 86 (1923); Blackall & Grieve, West. Austr. Wildflow. edn 1, 1: 293 (1953); Beard, West Aust. Pl. 98 (1965).

Stenospermum ericifolia (Sm.)Sweet ex Heynh., Nom. Bot. Hort. Dresden edn 1, 2: 787 (1841), as 'ericaefolia'.

Metrosideros propinqua Endl., Enum. Pl. Huegel 50 (1837); Walp., Repert. 2: 165 (1843) — non Salisb. (1796).

Type: Western Australia, King George Sound, *K.A.A. Hügel s.n.* (*holo.*: W).

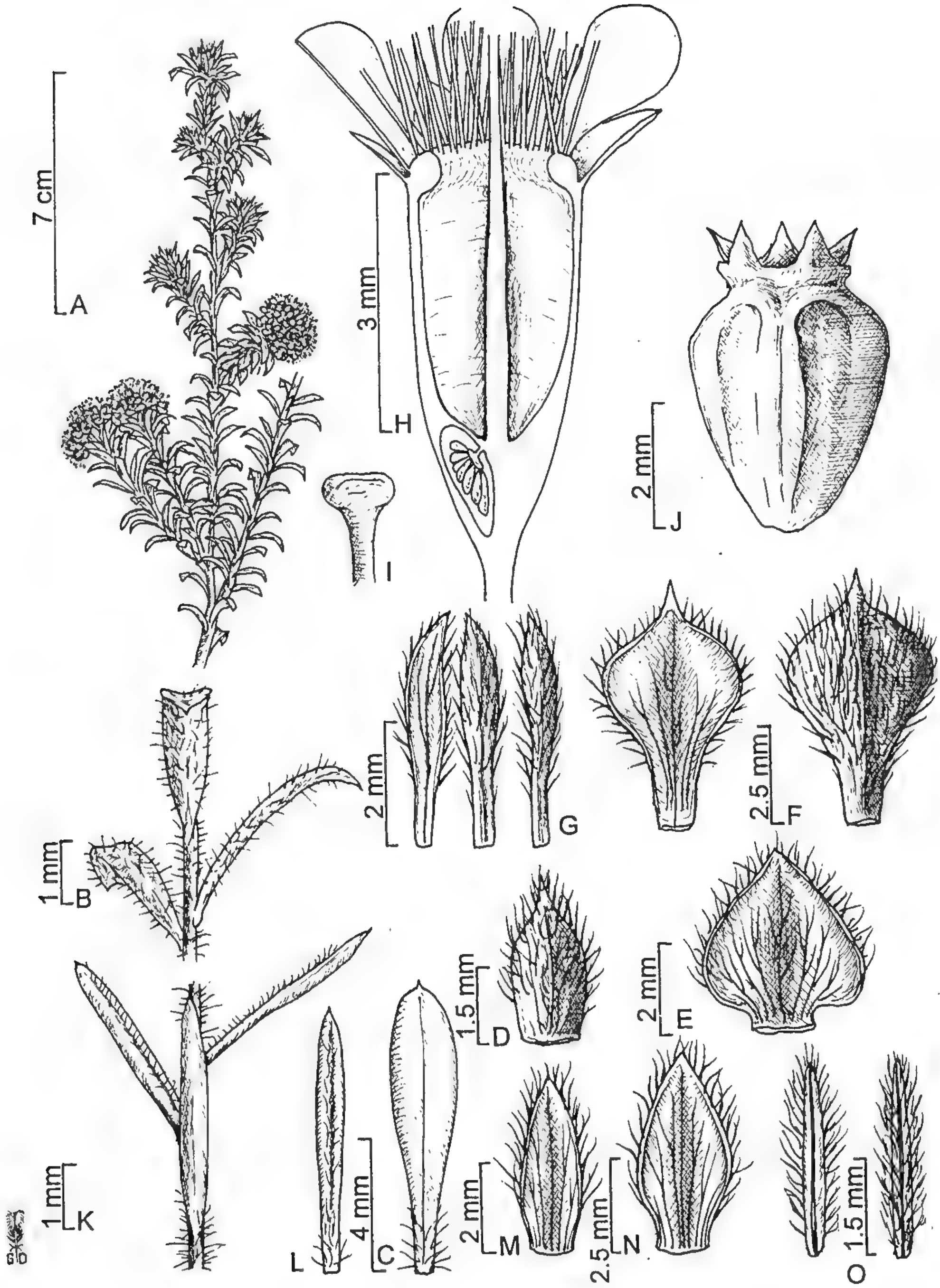


Fig. 4. *K. **ericifolia*** (Sm.)Rchb. ex Heynh. subsp. ***ericifolia***. A, flowering branch; B, branchlet with leaves hairy above and below; C, leaf; D, perule; E, lower bract, F, upper bract; G, bracteoles; H, half flower; I, stigma; J, fruit. – subsp. ***subulata*** Toelken. K, branchlet with leaves hairy above; L, leaf; M, perule; N, lower bract; O, bracteole. (A–I, *A.M. Ashby 2000*; J, *F. Oldfield MEL 92533*; K–O, *H.R. Toelken 7137*.)

Kunzea propinqua Schauer in Lehm., Pl. Preiss. 1: 126 (1844), partly as for type; Walp., Repert. 5: 742 (1844), partly.

Type: as for *Metrosideros propinqua* Endl. (see typification).

Kunzea vestita Schauer in Lehm., Pl. Preiss. 1: 126 (1844); l.c. 2: 224 (1848); A.D. Chapm., Contrib. Herb. Australiense 18: 2 (1976); Blackall & Grieve, West. Austr. Wildflow. edn 2, 3A: 98 (1980); Green, West. Austr. Pl. 77 (1981).

Type: Western Australia, near King George Sound, *J.A.L. Preiss 272* (*lecto.* — selected here: W; *isolecto.*: K, MEL (2×), W.

K. ericifolia var. *typica* Domin, Mém. Soc. Sc. Bohême (1921) 22, 2: 86 (1923), nom. illeg.

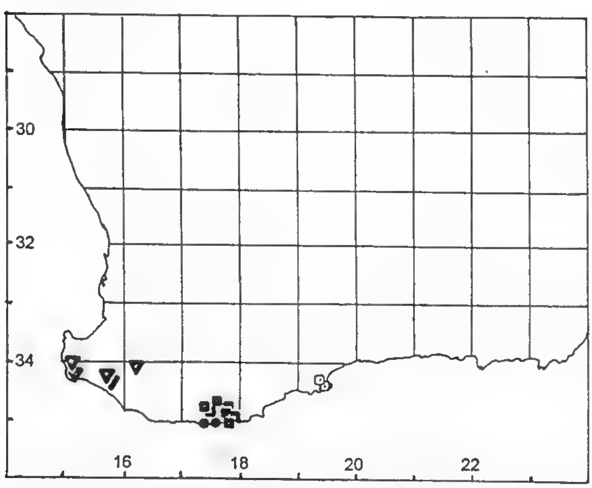
Young branches villous with mainly long hairs 0.5-0.7 mm. *Leaves* usually recurved to often more than 90° at least when old (if erect then broader than 1.5 mm), lanceolate to linear-lanceolate, (0.8-) 1.4-2.2 mm broad, flat or slightly convex below; *petiole* 0.4-0.8 mm long. *Flowers*: September, October. Fig. 4A–J.

Distribution and ecology

Known mainly from the area between Denmark, Mt Barker and just east of Albany where it grows usually in and around swamps or on the banks of creeks or rivers. A specimen from near Walpole (*A.R. Annels 839*) was based on a single plant and could be interpreted as naturalised there (J.R. Wheeler pers. comm.). Records from Wagin (*A.H.S. Lucas* NSW 124013) and Manjimup (*R. Hill & R. Jordan s.n.*, AD) could not be substantiated. Map 2.

Conservation status

Locally common.



Map 2. ***K. ericifolia*** subsp. ***ericifolia*** ◘; ***K. ericifolia*** subsp. ***subulata*** ⊡; ***K. spathulata*** ▼; ***K. clavata*** ●.

Variation

The leaves of this subspecies are usually dorsiventrally compressed, but in a few specimens, e.g. *E.M. Bennett 1082*, they range from flat to a somewhat convex abaxial surface. These leaves are oblong, 3–5 mm long, covered with long spreading hairs at least when young and have a petiole 0.5–0.7 mm long so that they cannot be confused with those of subsp. *subulata*.

Typification

Two specimens collected by Hügel from King George Sound are preserved in W. Since that specimen annotated in what seems to be Endlicher's handwriting 'Metrosideros propinqua n.sp.' has also densely hairy leaves and young branches — 'lanuginoso-villosis' in the protoloque — this must be the holotype. The second specimen which is much less hairy was already considered different and annotated by Beck '*Kunzea ericifolia* Rchb. var. *glabrior* (*K. propinqua* Schauer)'. It is here placed into 7(i) *K. clavata* × *K. ericifolia* subsp *ericifolia*. Endlicher's name is, however, a superfluous later homonym of *Metrosideros propinqua* Salisb. (1796), but it is a legitimate basionym (cf. A. 52.3) for *Kunzea propinqua* Schauer, which is treated here as a nomen novum (cf. A. 58.1). Therefore the same type applies as Schauer explicitly retained the type specimen in his

citation (cf. A. 48, 1) in spite of his protologue predominantly referring to *J.A.L. Preiss 271*, a specimen which is here included in *K. glabrescens*. Schauer also annotated the Hügel type specimen above Endlicher's name '*Kunzea propinqua* Schauer Pl. Preiss.' but neither of the two specimens of *J.A.L. Preiss 271* (W) bear any inscription in his hand.

Concerning the type of *K. vestita*, no specimen of *J.A.L. Preiss 272* was found in LD. Of the two specimens in Vienna (W) which Schauer would possibly have seen, the specimen with a Hügel label was selected as the lectotype because it is accompanied by collecting details as found in the protologue. The other three specimens (W, 2× MEL) lack that information.

Chapman (1976) changed the name of the species to *K. vestita* as he was at the time not aware that Heynhold (1840) had validly published the combination *K. ericifolia* before Mueller (1855) published a later homonym.

Selection of specimens examined (ca 45 seen)

WESTERN AUSTRALIA: *A.M. Ashby 2000*, Lower King, 10.x.1966 (AD, PERTH); *W. Baxter NSW 124021*, King George Sound, ca 1828 (NSW); *E.M. Bennett 1082*, Lower King Road, Albany, 16.ix.1966 (PERTH); *H. Davies 564*, Porongorup, 7.ix.1950 (AD); *J. Galbraith 806*, Albany, 3.x.1964 (MEL); *B.T. Goadby 93*, King George Sound, -.x.1896 (NSW); *B.T. Goadby B.2161?*, King George Sound, -.x.1898 (PERTH); *J.H. Maiden NSW 124023*, King George Sound, xi.1909 (NSW); *A. Meebold 11661*, Mt Barker, viii.1933 (PERTH); *F. Mueller MEL 92529*, King George Sound, -.x.1867 (MEL); *MEL 92530*, King George Sound, -.x.1867 (MEL); *MEL 92533*, Torbay (MEL); *MEL 92534*, King George Sound, x.1867 (MEL); *K. Newbey 973*, 3 mls N Albany, 21.ix.1963 (PERTH); *S.P. Pfeiffer 31*, Upper King, ix.1958 (PERTH); *H.R. Toelken 7174*, 5 km NW King River, 2.xi.1981 (AD); *7178*, 22 km N Denmark, 2.xi.1981 (AD); *G.L. Webster 18771*, Lake Powell, 23.ix.1973 (NSW); *F.W. Went 134*, near Denmark, 15.ix.1962 (PERTH); *E. Wittwer 263*, Millbrook Creek Road, Albany, 27.ix.1963 (PERTH).

Putative hybrids

4a(i) *K. clavata* × *K. ericifolia* subsp. *ericifolia* see 6(i) *K. clavata*.

4a(ii) ***K. ericifolia* subsp. *ericifolia* × *K. recurva*.**

The folded leaves with usually acute apex as well as the bracts which are acute or bluntly acute and hairy over much of the surface show its resemblance to *K. ericifolia* subsp. *ericifolia*. However, the broad leaves, pink petals and long hairs (short in *K. ericifolia*) on bracts on floral axis relate to *K. recurva*, the only pink-flowered species recorded from King George Sound. The calyx lobes have sometimes in bud the typical recurved margins of *C. recurva* but at the flowering stage the margins are scarcely incurved and are similar to those of *K. ericifolia*, the only other species common in that area.

Specimen examined

WESTERN AUSTRALIA: *B.T. Goadby 2163*, King George Sound, -.x.1898 (PERTH).

4b. subsp. **subulata** Toelken, *subsp. nov.*

A subsp. *ericifolia* foliis rectis, subulatis convexissimis subtus pilis paucis longis supra, petiolis 0.8-1.5 mm longis differt.

Type: Western Australia, West Mt Barren, *H.R. Toelken 7137* (*holo.*: AD; *iso.*: B, C, G, K, LE, MEL, MO, NSW, NY, PERTH, S).

Young branches villous with short and long hairs up to 3.5 mm long and usually shorter than those of leaves. *Leaves* linear rarely linear-lanceolate, very convex below to semicircular in section but flat or slightly grooved above with hairs, straight or if slightly recurved then from the petiole; *petiole* 0.8–1.5 mm long. *Flowers*: September, October. Fig. 4K–O.

Distribution and ecology

Known only from the vicinity of West Mt Barren where plants grow among rocks towards the summit but it has also been recorded from lakes nearby. Map 2.

Conservation status

Very localised but several populations conserved in Fitzgerald River National Park.

Variation

The plants growing among rocks on top of and on the southern slopes of West Mt Barren form spreading shrubs to 1.5 m high and their terminal branches are usually short and gnarled. These shrubs have quite a different appearance from those of the typical subspecies but plants of subsp. *subulata* growing around a nearby lake, e.g. *Royce 9105*, which was described as 'erect many-stemmed shrub 6-8 ft tall'. This aptly describes the habit of the typical subspecies although according to all other characters this specimen must be identified as subsp. *subulata*.

Etymology: The epithet 'subulata' (= awl-shaped, Lat.) refers to the leaves of that shape.

Specimens examined

WESTERN AUSTRALIA: *A.S. George 6972*, West Mt Barren, 28.x.1965 (PERTH); *K. Newbey 2884*, West Mt Barren, 20.ix.1969 (PERTH); *R.D. Royce 9105*, around salt lake SE Mt Bland, 20.x.1970 (PERTH); *A. Strid 20966*, West Mt Barren, 23.x.1982 (AD); *H.R. Toelken 7137*, West Mt Barren, 30.x.1984 (AD, B, C, G, K, LE, MEL, MO, NSW, NY, PERTH, S); *E. Wittwer 1991*, West Mt Barren, 14.i.1982 (KPBG).

5. **K. spathulata** Toelken, *sp. nov.*

K. ericifolia (Sm.)Rchb ex Heynh. var. *glabrior* auct. non Benth.: Domin, Mém. Soc. Sci. Bohême (1921) 22, 2: 86 (1923).

A *Kunzeis* similibus foliis ramisque glabris, inflorescentis usque ad 8 mm diametro, et bracteolis obovato-spathulatis truncatis differt.

Type: Western Australia, 26 miles S Nannup, *V. Mann & A.S. George 77*, (*holo*.: PERTH; *iso*.: K, NSW).

Tall shrubs or trees up to 4.5 m high, with a number of erect stems, much branched with ascending branches; young branches slender (0.4–0.6 mm in diameter), flanges faint with ridges below each leaf, glabrous rarely with scattered hairs when very young; early bark fibrous-mosaic becoming corky with shallow fluting. *Leaves*: *petiole* 0.4–0.8 mm long, more or less appressed, broadened towards the base; *lamina* linear, rarely linear-elliptic, (4-) 5–7 × 0.4–0.6 (–0.75) mm, with abrupt blunt apex, gradually tapering into petiole, flat or almost so above, strongly convex below, spreading and rarely slightly recurved, glabrous. *Inflorescence* a sphaerical or elongate botryum with 10–18 spreading flowers, terminal on branches and rarely clustered at the apex on long and short shoots, with some terminal vegetative growth after flowering; *perules* below inflorescence few and often less than 5, broadly ovate, with bluntly acute, rarely mucronate apex, glabrous or with few hairs on the base of the abaxial surface, with 3, 5 (7) branching veins; *bracts* broadly obovate below to angular oblong-obovate or rhombic with 2 hyaline wings on an oblong centre with upper flowers, 2–3 (–3.5) × 1.8–2.5 (–3) mm, fleshy central midrib with 1 vein, with a tuft of forward-directed hairs on the lower abaxial surface, hyaline margins sometimes reduced to short wings; *bracteoles* in pairs, obovate-spathulate to angular-spathulate, (2–) 2.5–3.5 × 1–2.2 mm, truncate or central ridge continued into short terminal point with 1 vein, with few hairs on the abaxial base. *Hypanthium* 2.5–3.2 mm long when flowering (free tube 1.5–1.8 mm) slightly ridged towards the base, glabrous. *Calyx lobes* ovate-triangular, 0.5–0.7 mm long, bluntly acute, glabrous. *Corolla lobes* obovate-orbicular, usually without distinct

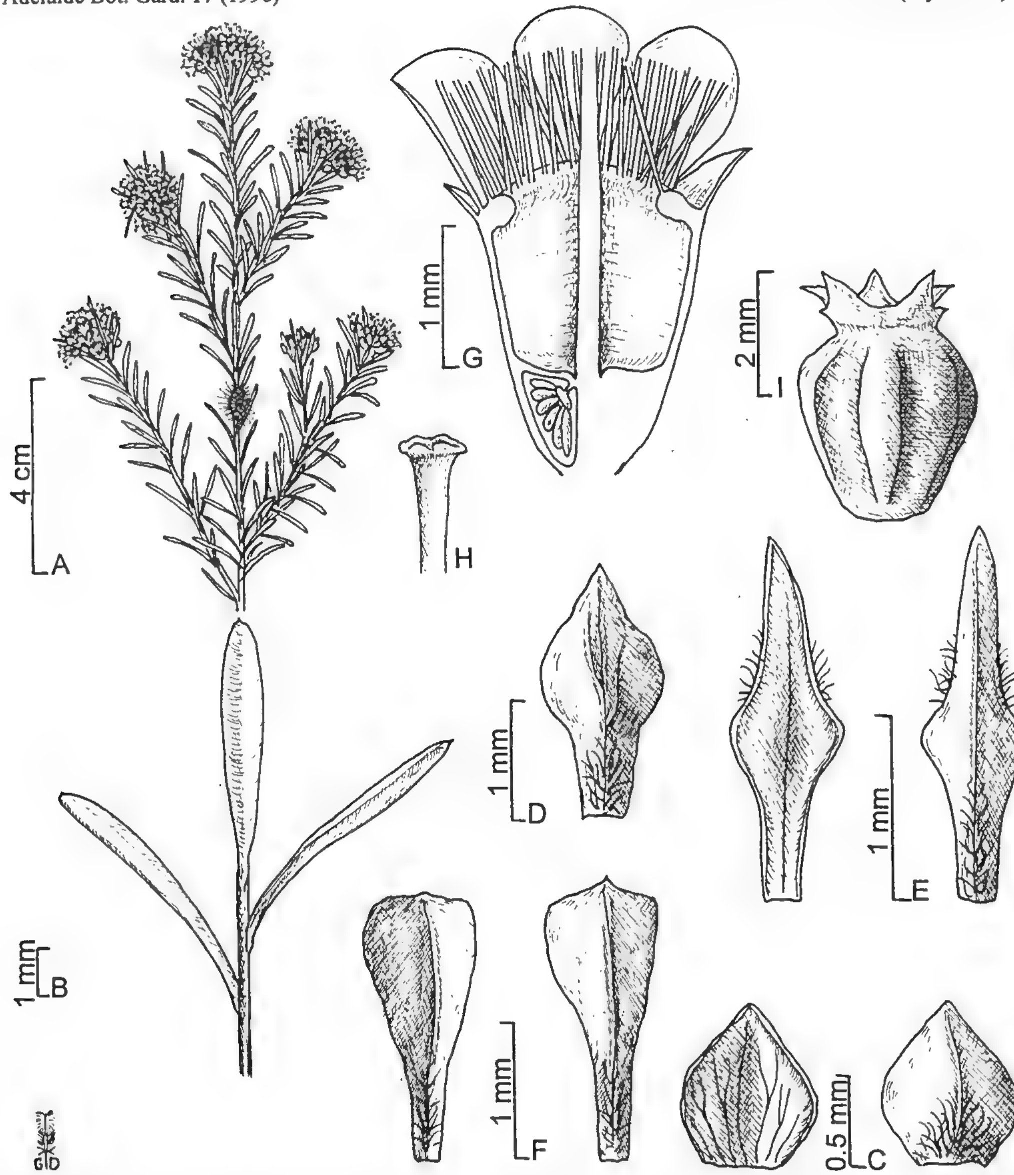


Fig. 5. ***K. spathulata*** Toelken. A, flowering branch; B, glabrous branchlet; C, perule; D, lower bract; E, upper bracts; F, bracteoles; G, half flower; H, stigma; I, fruit. (A–H, *V. Mann & A.S. George 77*; I, *R.D.Royce 5414*.)

claw, 1.6–2 mm long, yellow or yellowish-green. *Stamens* 26–30 in more than one whorl; *filaments* 2.6–2.9 mm long; *anthers* with small subterminal gland. *Ovary* 5-celled, with style scarcely sunk into the upper surface; placenta a narrowly elliptic fleshy disc with short central attachment, scarcely 2-lobed except in the centre, each lobe with 1 row of ovules; ovules 9 or 10 per locule, spreading, with lowest 2 pendulous and often slightly longer; style 3.1-4.3 mm long; stigma small to moderately expanded. *Fruit* not seen. *Flowers:* October, November. Fig. 5.

Distribution and ecology

Recorded from sandy soil usually associated with swampy areas mainly in the extreme south-western corner of Western Australia. The main populations seem to occur near Augusta and south of Nannup but the one record NW of Pemberton shows that it might

have a much wider distribution. The record from West Cape Howe, near Denmark, could, however, not be confirmed. Map 2.

Conservation status

Not common although found in a few large populations outside conserved areas.

Diagnostic features

Although superficially similar to *K. glabrescens* and *K. ericifolia* it is distinguished by its glabrous young leaves and branches, the obovate-spathulate truncate bracteoles and small inflorescences. All organs of this species tend to be smaller and more delicate than other members of the subsection although the plants themselves are recorded up to 15 feet high (*Mann & George 77*), which is considerably taller than records for *K. glabrescens* and *K. ericifolia*.

Variation

A fruiting specimen, *R.D. Royce 5414* from West Cape Howe, agreed in all aspects with this species, but the occurrence of this species so far from the main distribution of the species and so close to the distribution of the similar *K. clavata* could not be confirmed.

As is also exhibited in *K. glabrescens*, the bracts of late inflorescences have the tendency to elongate excessively, a phenomenon shown in a number of inflorescences of the type collection.

The bracts and bracteoles of specimen *R.J. Cranfield 959* are densely hairy at the base, along the margins, and more or less on the inner surface.

Notes

The earliest record of this species is a collection by *Mrs McHard s.n.*, 1892 (MEL 92781), from Blackwood River. This is of particular interest since she had collected a few years earlier, i.e. in 1883 (MEL 92803), a specimen of *K. glabrescens* along the same river. The latter species is nowadays very rare so far south and was probably collected higher up the river then the *K. spathulata* specimen.

Etymology: The epithet '*spathulata*' (Lat.) refers to spathulate bracteoles of this species.

Specimens examined

WESTERN AUSTRALIA: *R.J. Cranfield 959*, along road from Nannup to Bridgetown, 2.xi.1978 (AD, PERTH); *Mrs McHard* MEL 92781, Blackwood River, -.-.1892 (MEL); *V. Mann & A.S. George 77*, 42 km S Nannup, 11.xi.1969 (K, NSW, PERTH); *R.D. Royce 5414*, West Cape Howe, 7.iii.1956 (PERTH); *R. Tinetti s.n.*, Nannup - Pemberton road, 13.xi.1974 (PERTH); *H.R. Toelken 6442*, 35 km NW Pemberton, 5.x.1979 (AD, PERTH); *7893*, 5 km N Brockman Highway on road to Augusta, 25.ix.1988 (AD, PERTH); *D.J.E. Whibley 5083*, just west of Augusta, 6.xi.1974 (AD, PERTH).

6. **Kunzea clavata** Toelken, *sp. nov.*

K. spathulatae similis sed bracteis et bracteolis basipetis glabris, bracteis truncatis differt;

a *K. ericifolia* et *K. glabrescenti* foliis et ramis glabris, foliis clavatis differt.

Type: Western Australia, near Bornholm, *H.R. Toelken 7903* (*holo.*: AD; *iso.*: K, NSW, PERTH).

Shrubs or trees with several stems from the base, 2.5–4 m tall, much branched; young branches often strongly ridged, glabrous; early bark fibrous-mosaic becoming corky with

shallow fluting. *Leaves*: *petiole* 0.7–0.8 (–0.9) mm long, appressed to branches, not broadened towards the base; *lamina* linear, linear-oblanceolate to almost club-shaped, (2.7-) 2.8–4 (–4.8) × 0.6–0.75 mm, scarcely but gradually tapering into petiole, abruptly constricted into blunt apex, usually slightly convex above and strongly convex below, straight and recurved from petiole, glabrous. *Inflorescence* a sphaerical botryum with 22–34 spreading flowers in dense heads, terminal mainly on long shoots, with terminal vegetative growth rarely persisting; *perules* usually more than 5, depressed ovate to obovate, usually truncate or rounded, glabrous or minutely hairy, with 1 to few veins; *bracts* broadly obovate to obovate-spathulate, 3.2–3.4 × 3.1–3.4 mm, usually with 2 hyaline wings, rounded or truncate, rarely mucronate, with central vein pronounced and 2, rarely few, lateral ones from the base, glabrous or with a few long hairs particularly on upper parts of the inflorescence; *bracteoles* in pairs, oblanceolate-spathulate to obovate-spathulate, 2.3–3.2 × 1.5–1.7 mm, truncate or emarginate and rarely mucronate, with central vein often ridged, lateral wings hyaline, glabrous or with a few long hairs along the main vein. *Hypanthium* 2.8–3.2 mm long when flowering (free tube 1.2–1.3 mm), ridged and often with obvious veins towards the base, glabrous. *Calyx lobes* triangular, 1–1.1 mm long, bluntly acute, glabrous. *Corolla lobes* broadly elliptic to orbicular, usually without distinct claw, 1.6–2 (–2.2) mm long, pale yellow. *Stamens* (27–) 30–35 in more than one whorl; filaments 3.1–3.4 mm; anthers with small subterminal gland. *Ovary* 5-celled, with style slightly sunk into the upper surface; placenta a narrow-elliptic fleshy disc with short almost central attachment, scarcely 2-lobed except in the centre, each lobe with 1 row of ovules; ovules (9) 10 or 11 per locule, spreading but lowest 2 pendulous and often slightly longer; style 3.9–4.6 mm long; stigma usually more or less capitate. *Fruit* urn-shaped capsule with locules somewhat bulging, calyx erect. *Flowers:* (September) October. Fig. 6.

Distribution and ecology

Associated with lakes and marshy areas, but very restricted in its distribution and found only in a few coastal localities just east of Denmark. Map 2.

Conservation status

Locally common at present but the species needs to be monitored since it has a restricted distribution associated with marshy habitats.

Etymology: The epithet clavatus (= club-shaped, Lat.) is used here in the sense of a baseball club, which, as is sometimes found in the leaves of this species, increases gradually towards the apex and lacks a terminal knob.

Specimens examined

WESTERN AUSTRALIA: *R. Story 8259*, 25 km W Albany, 19.ix.1976 (CANB, PERTH); *H.R. Toelken 7902*, near Bornholm, 26.ix.1988 (AD, PERTH); *7903*, near Bornholm, 26.ix.1988 (AD, K, NSW, PERTH); *C.T. White 5398*, Hortons Siding on Denmark Railway, 8.xi.1927 (BRI).

Putative hybrids

6(i) ***K. clavata* × *K. ericifolia* subsp. *ericifolia***

Most characters agree with those of *K. clavata* but the organs tend to be somewhat larger and more robust. Since the bracts and bracteoles are velutinous as in *K. ericifolia*, and young branches and leaves are sparsely hairy unlike either species, these plants are

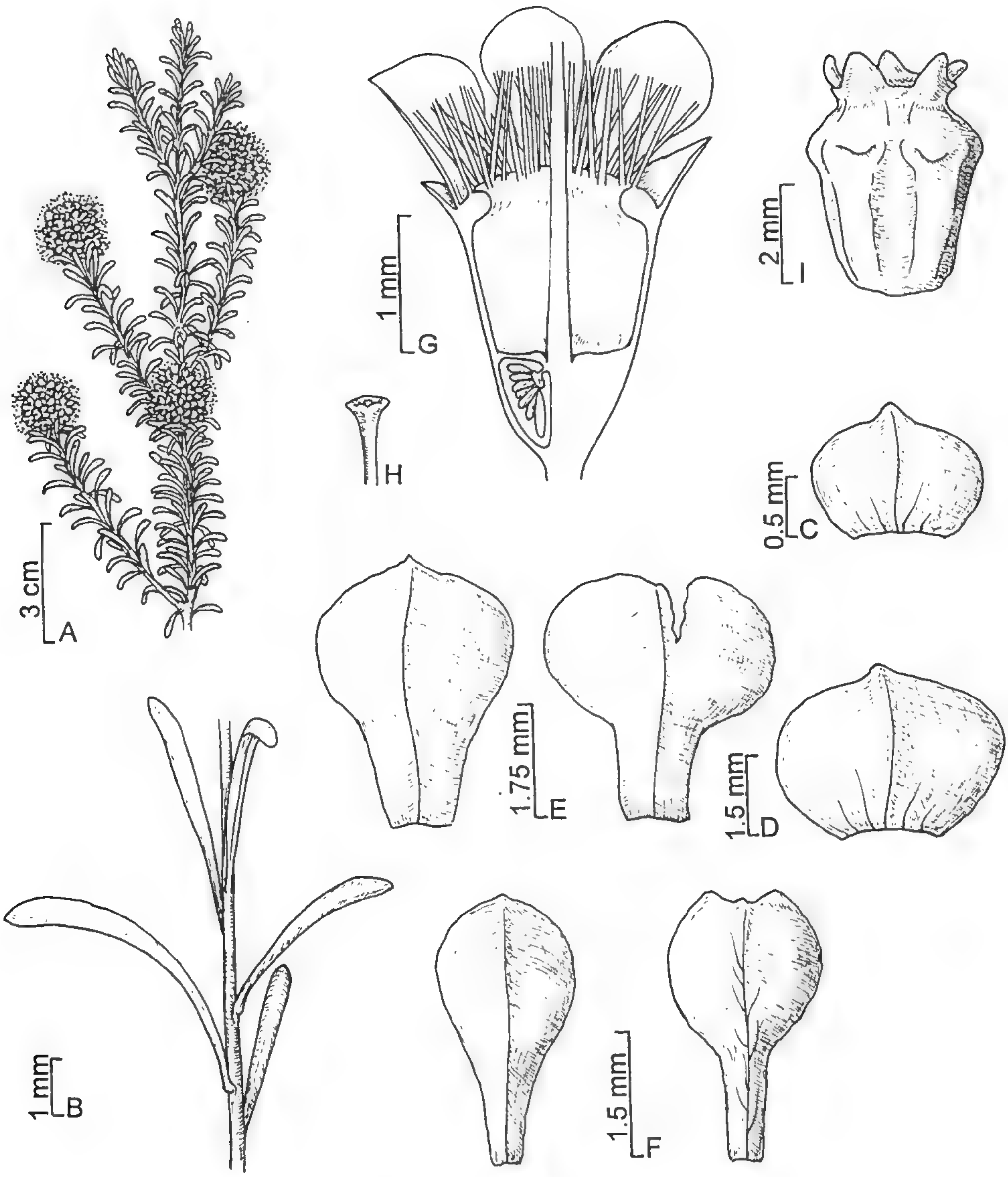


Fig. 6. ***K. clavata*** Toelken. A, flowering branch; B, glabrous branchlet; C, perule; D, lower bract; E, upper bract; F, bracteole; G, half flower; H, stigma; I, fruit. (A–I, *H.R. Toelken 7903.*)

somewhat intermediate. They were recorded from an area where the two species could theoretically have had extensive populations but due to extensive agricultural activity are now restricted to scattered plants along roadsides. It could therefore not be assessed whether this is merely a form of *K. clavata* or, indeed, a remnant hybrid population. It is interesting that the second specimen collected by Hügel at King George Sound in 1833 (cf. 5a, typification of *K. propinqua*) must be placed here.

Specimens examined

WESTERN AUSTRALIA: *E.M. Canning CBG 40063*, 11.3 mls E Young Siding towards Albany, 12.x.1968 (CBG); *K.A.A. Hügel s.n.*, King George Sound (W - annotated by Beck 'Kunzea ericifolia Rchb. var. glabrior (K. propinqua Schauer)'); *H.R. Toelken 7904*, ca 6 km SW of Albany, 26.ix.1988 (AD); *7905C*, ca 6 km SW of Albany, 26.ix.1988 (AD).

6(ii) *K. clavata* × *K. recurva*

The rounded to truncate apex of the bracts and bracteoles, the spathulate bracteoles, and the glabrous stems are all reminiscent of *K. clavata*. The pale pink or yellowish-pink petals, the broad flat leaves (although broad-elliptic not broad-obovate as usual in forms in that area), and the long stiff hairs on the base of the bracts and bracteoles indicate that *K. recurva* must have been the other putative parent. Plants of neither of the parent species were found in the immediate vicinity.

Specimens examined

WESTERN AUSTRALIA: *H.R. Toelken 7905A & B*, ca 6 km SW Albany, 26.ix.1988 (AD).

B. **Kunzea** subsect. **Globosae** Toelken, *subsect. nov.*

A subsect. *Arborescentibus* fruticibus rare ad 2.5 m altis, floribus roseis vel purpureis, rare candidis; a subsect. *Floridis* (10–) 15–35 (–50) floribus in inflorescentia, staminibus petala superantibus differt.

Type species: *K. recurva* Schauer.

Shrubs 0.2–1.2 (–2.5) m tall, with few spreading or decumbent stems each with spreading branches and usually without short shoots; bark on young branches (5–15 mm diam.) usually more or less fluted and fibrous, rarely somewhat corky. *Leaves* oblanceolate to broadly elliptic or obovate, usually with horny margin which is more or less erose at least when young. *Inflorescence* with (10–) 15–35 (–50) flowers in globular to elongate heads, with vegetative growth after flowering from the terminal bud, but often not continued and main growth from unrelated buds. *Petals* obovate to orbicular or depressed obovate, shorter than stamens, rose-pink to deep purplish-pink, rarely pale pink mainly in hybrids or white in forms of *K. micrantha*.

Distribution and ecology

Of the species found in subsect. *Globosae* only *K. micrantha* is usually found in swampy areas or in localities which are flooded at least when plants are flowering; other members of the subsection are often associated with winter-wet depressions, but they usually grow on the margins of temporary swampy areas. A few species, such as, *K. ciliata*, *K. praestans* and *K. micromera* are often found on gravelly slopes. The subsect. *Globosae* has the widest distribution and covers most areas also covered by subsects. *Arborescens* and *Floridae*, viz. south-western Western Australia westwards from Stokes Inlet to Geraldton and Wubin in the north-west. All species, except occasionally for *K. micrantha*, mainly skirt the forested areas of southern Western Australia or, if they are found there, they occur in pockets of heath-like vegetation or have established themselves, it seems, secondarily as the result of clearing. Species of this subsection are, like those of the subsect. *Floridae*, often pioneer plants in wet disturbed areas.

Notes

In the subsect. *Globosae* there are two groups of species which, as in the subsect. *Floridae*, must be interpreted as divergent lines within this group. The first three species show a close resemblance to *K. recurva*, while the others are more similar to, or indirectly

linked through another species to *K. praestans*. It appears to be a natural group although it is described largely by the exlusion of subsections *Arborecentes* and *Floridae*.

The growth habit of species of subsect. *Globosae* is often even more untidy and inconsequent to those of subsect. *Arborescentes*. It is unknown whether the rather feeble, if any, continued growth from the apex of the inflorescence and the main growth's continuing from lateral (or other) buds, is 'suited' to or results from their usually very spreading to decumbent habit. Young plants do not usually develop inflorescences terminal to the main branches and, since these main branches continue growth during the flowering period, vegetative growth soon overtops the fruiting branches which do not contribute to vegetative growth (cf. Fig. 14A). Mature plants on the other hand are often reactivated from lower parts of branches which have since become decumbent. In such cases an axillary bud below an old inflorescence often forms a new erect branch system. The development of such new growth centres, except on young main branches, are often quite unpredictable and are not related to the inflorescences, or if they are then here, as in the subsect. *Arborescentes*, not all branches end in an inflorescence. Also, in contrast to the *Arborescentes* the *Globosae*, as with the *Floridae*, have mainly grey fibrous fluted bark.

The number of flowers per inflorescence is usually well above ten and in *K. micrantha* may even reach 50. The exception is *K. micromera* with (6–) 12–18 (–24) flowers, but this species was (unlike *K. similis*) not placed in the *Floridae*, because of its decumbent habit with a growth pattern as described above, and because of the very pronounced horny margins on the leaves. Clusters of botrya on short shoots below the terminal inflorescence are like short shoots in general, rarely found in the *Globosae*, and, if present, these are only represented by a few lateral botrya.

Key to the species, subspecies and hybrids of subsect. Globosae

N.B. The size and shape as well as tomentum of the first three leaves produced on each branch are often abnormal and should not be used.

1. Hypanthium hairy; calyx usually with some hairs, often becoming glabrous:
   2. Leaves with few hairs along the margin or glabrous:
      3. Calyx lobes glabrous, bluntly acute to rounded, greyish and with a prominent ridge .... 12d. *K. micrantha* subsp. *hirtiflora*
      3: Calyx lobes sericeous, pointed, green to red and with a faint ridge towards the apex .... 15. *K. acuminata*
   2: Leaves densely hairy at least below, becoming glabrous:
      4. Apex of bracts rounded to almost truncate; north of Perth:
         5. Leaf lamina gradually constricted into base without petiole; petals (2.5–) 2.8–4 (–5) mm broad .... 11. *K. praestans*
         5: Leaf lamina abruptly constricted into petiole; petals 1.8–2.2 (–2.5) mm broad .... 12b. *K. micrantha* subsp. *petiolata*
      4: Apex of bracts bluntly acute to cuspidate; south-east of Perth:
         6. Ovary 3-locular; calyx lobes pointed .... 14. *K. similis*
         6: Ovary 5-locular; calyx lobes bluntly acute or rounded .... 13(iii). *K. micromera* × *K. preissiana*

1. Hypanthium and calyx glabrous:
   7. Margins of shiny calyx lobes recurved .... 7. *K. recurva*
   7: Margins of usually dull calyx lobes incurved or spreading:
      8. Leaf lamina with cuneate base in a straight line from the broadest point to compressed base (petiole absent) .... 11. *K. praestans*
      8: Leaf lamina more or less abruptly constricted into bulging petiole:
         9. Young branches covered with blunt papillae or short hairs spreading at right angles .... 9. *K. rostrata*
         9: Young branches glabrous or if with aciculate hairs then these more or less appressed:
            10. Lower flowers on inflorescence curved upwards:

11. Calyx lobes acute, stiffly erect after flowering, and with raised veins on hypanthium continued to their apex.. 12a. *K. micrantha* subsp. *micrantha*
11: Calyx lobes bluntly acute or rounded, incurved and closing the opening of the hypanthium after flowering, and with raised veins only on part of the hypanthium:
12. Floral axis glabrous except for stipuline bristles; hypanthium with vertical ridges .... 12c. *K. micrantha* subsp. *oligandra*
12: Floral axis with short hairs hiding the stipuline bristles; hypanthium with vertical ridges on the ovary and then with horizontal bulge .... 12c(i). *K. micrantha* subsp. *oligandra* × *K. micromera*
10: Lower flowers on the inflorescence straight or almost so:
13. Young branches with coiled or crisped hairs:
14. Calyx lobes greyish and incurved after flowering; ovary with 2,3(–5) locules .... 12c(i). *K. micrantha* susbp. *oligandra* × *K. micromera*
14: Calyx lobes green and erect or spreading after flowering; ovary with 5 locules:
15. All branches woody and rigid.............................. 1(ii). *K. montana* × *K. recurva*
15: Lateral branches thin and wiry:
16. Leaves obovate to almost orbicular, (18-) 20–26 mm broad .... 1(ii). *K. montana* × *K. micromera*
16: Leaves oblanceolate, 13–17 mm broad....13(iv). *K. micromera* × *K. recurva*
17. Lower bracts to 3 mm broad ....13. *K. micromera*
17: Lower bracts 4–4.6 mm broad.......... 13(ii). *K. micromera* × *K. montana*
13: Young branches glabrous or with straight hairs:
18. Bracts glabrous except for marginal cilia:
19. Inflorescence elongate; bracts fleshy..10. *K. ciliata*
19: Inflorescence globose; bracts coriaceous to membranous...............8. *K. newbeyi*
18: Bracts at least hairy dorsally along the central vein and with or without marginal cilia:
20. Lower bracts bluntly acute to cuspidate:
21. Calyx lobes greyish and incurved after flowering; leaves flat or slightly convex above, rounded .... 12c(ii). *K. micrantha* subsp. *oligandra* × *K. recurva*
21: Calyx lobes green and erect or spreading; leaves concave to folded above, bluntly acute to acute........4a(ii). *K. ericifolia* subsp. *ericifolia* × *K. recurva*
20: Lower bracts truncate to rounded:
22. Ovary with (2) 3–5 locules each with (3) 4–6 (–8) ovules; bracts shorter than hypanthium:
23. Petals 1.8–2.2 (–2.5) mm broad .... 12b. *K. micrantha* subsp. *petiolata*
23: Petals 2–2.5 (–2.7) mm broad .... 12b(i). *K. micrantha* subsp. *petiolata* × *K. praestans*
22: Ovary with 5 locules, each with 8–12 ovules; bracts longer than or rarely as long as hypanthium:
24. Calyx lobes greyish, incurved after flowering; petals pink .... 12c(iii). *K. micrantha* subsp. *oligandra* × *K. recurva*
24: Calyx lobes green, erect to spreading after flowering; petals pale pink
25. Bracteoles spathulate-obovate; leaf lamina broadly elliptic .... 6(ii). *K. clavata* × *K. recurva*
25: Bracteoles sessile obovate; leaf lamina obovate to broadly obovate .... 7(vii). *K. recurva* × *K. sulphurea*
25: Bracteoles sessile obovate; leaf lamina oblong-oblanceolate............ .... 7(iii). *K. glabrescens* × *K. recurva*

7. **K. recurva** Schauer in Lehm., Pl. Preiss. 1: 125 (1844); Benth., Fl. Austr. 3: 114 (1867); Domin, Mém. Soc. Sci. Bohême (1921) 22, 2: 87 (1923); Blackall & Grieve, West. Austr. Wildflow. edn 1, 1: 294 (1954); Beard, West Austr. Pl. 98 (1965); J. Green, Census Vasc. Pl. West. Austr. edn 2, 128 (1985); Rye in N.G. Marchant et al., Fl. Perth Region 1: 410 (1987), partly.

Type: Western Australia, 'in calculosis ad radices montium Darling's-range', *J.A.L. Preiss 290* (*lecto.* — selected here: LD; *isolecto.*: G, MEL 92342, 92343, W; *syn.*: *J. Drummond 27*, W).

K. recurva var. *melaleucoides* F. Muell. ex Benth., Fl. Austr. 3: 114 (1867), partly, excl. *A.F. Oldfield*, Vasse River; Domin, Mém. Soc. Sc. Bohême (1921) 22, 2: 87 (1923); Blackall & Grieve, West. Austr. Wildflow. edn 2, 3A: 98 (1980).

Type: Western Australia, Tone River, *A.F. Oldfield 353b* (*lecto.* — selected here: MEL 92348; *isolecto.*: K; *syn.*: Tone River, *A.F. Oldfield 356b*, K; Bald Island, *G. Maxwell s.n.*, MEL 92349; Cape Riche, *G. Maxwell s.n.*, MEL 92350).

K. spicata S. Moore, J. Linn. Soc., Bot. 45: 203 (1920); Blackall & Grieve, West. Austr. Wildflow. edn 1, 1: 294 (11954); Beard, West Austr. Pl. 98 (1965); Blackall & Grieve, West. Austr. Wildflow. edn 2, 3A: 98 (1980); J. Green, Census Vasc. Pl. West. Austr. edn 2, 128 (1985).

Type: Western Australia, 'on West Mt Barren, the Fitzgerald River', *G. Maxwell s.n.* (*holo.*: BM).

Shrubs 0.3–1.5 (–2) m tall, usually with several spreading, ascending or rarely almost decumbent main branches, usually much branched; young branches with decurrent flanges scarcely raised, more or less densely covered with forward-directed, straight hairs, particularly at the base of petioles and or near the inflorescences, sometimes glabrous or becoming so; early bark fibrous-mosaic, becoming fibrous-peeling and more or less coarsely fluted. *Leaves*: *petiole* (0.3–) 0.5–1 (–1.3) mm long, appressed, recurved to spreading at least in the upper part; *lamina* obovate, rarely obovate-spathulate to oblong-obovate, (1.3–) 1.9–2.6 (–4.2) × (1.3–) 1.7–2.7 (–3.6) mm, usually truncate and mucronate to bluntly acute, rarely acute or acuminate mainly when immature, usually abruptly tapering into petiole, flat to slightly concave above, flat to somewhat convex below, usually recurved from the middle when mature, glabrous. *Inflorescence* a spherical botryum, rarely elongate,with (12–) 15–27 (–39) flowers, terminal on long and short shoots and often clustered at the end of branches, sometimes with terminal growth after flowering but more often growth will continue from other branches or from the same branch below but not be related to the inflorescence; *perules* usually less than 5, ovate, with 1–3 veins, usually glabrous; *bracts* ovate-spathulate with stalk becoming longer on upper parts of the inflorescence, 2–3.4 × (1.8–) 2.4–3.2 mm, abruptly acute, bluntly acute, rounded or rarely almost truncate, with few to one vein, usually with few long hairs mainly from the base; *bracteoles* in pairs, linear-oblanceolate to oblanceolate, 2–3 × (0.8–) 1–1.8 mm, bluntly acute, with more or less hyaline margin, with few to many long hairs along the central vein and base. *Hypanthium* 2.8–3.3 mm long when flowering (free tube 1.6–1.8 mm), glabrous. *Calyx lobes* ovate to lanceolate or oblong-lanceolate, 1–1.6 mm long, bluntly acute or rounded, with recurved lateral margins, glabrous and shiny. *Corolla lobes* obovate-spathulate, 1.8–2.3 (–2.6) mm long, clawed, pink to rose purple. *Stamens* 21–34 (–40) in more than one whorl; filaments 3.5–4.9 mm long; anthers with almost terminal gland. *Ovary* with 5 locules, surmounted by a slightly broadened style base somewhat sunk into the upper surface; placenta narrowly elliptic, scarcely fleshy disc with conical attachment connected to the middle, with lobes connate on the outside margins, each lobe with two rows of ovules; ovules 8–12 (–14) per locule, spreading or lowest ones pendulous and slightly longer; style 3.8–5.2 mm long; stigma slightly broadened disc. Fruit an urceolate capsule with erect calyx lobes. *Flowers:* (August) September-November (December). Fig. 7.

Distribution and ecology

Widespread but usually only locally common from east of Bremer Bay in the south-east to near Augusta in the south-west and to near Perth in the north; growing in a wide variety of substrates usually in or near wet areas in depressions or lower slopes and very often with other species. Map 3.

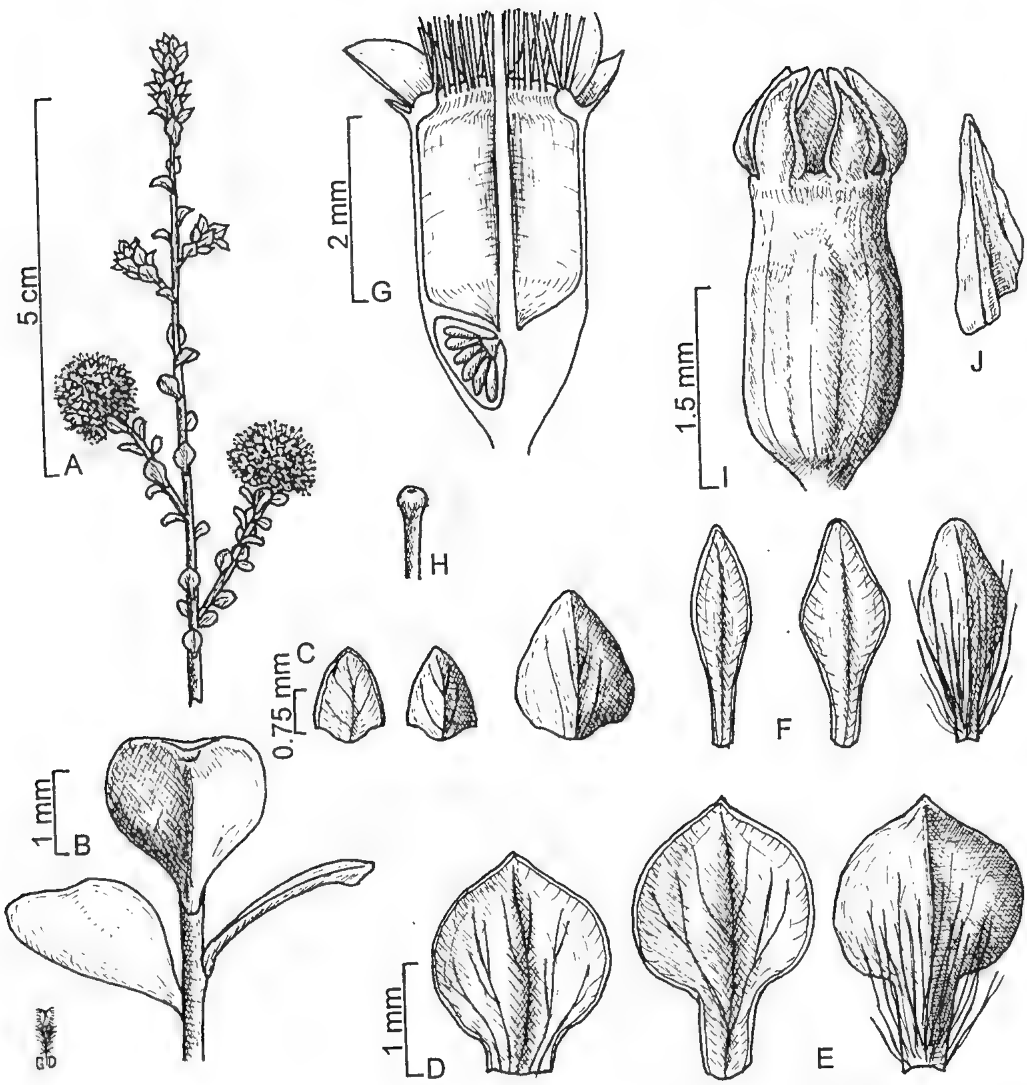


Fig. 7. ***K. recurva*** Schauer. A, flowering branch; B, branchlet; C, perules; D, lower bract; E, upper bract; F, bracteoles; G, half flower; H, stigma; I, fruit; J, recurved calyx lobe. (A–H, *H.R. Toelken 7171*; I, J, *J.W. Green 965*.)

Conservation status

K. recurva is not rare because it is widespread and often locally common.

Diagnostic features

Although *K. recurva* is similar to one or other form of most of the species in this subsection it is easily distinguished by the recurved lateral margins of the usually shiny calyx lobes. They may be flattened in flowers but are usually clearly visible in buds. Both of these characters are unique in this section of *Kunzea*, but one or usually both are lost in hybrids. The specific epithet is, however, not based on the recurved calyx lobes, but is thought to be based on recurved old leaves as the author changed the epithet from 'rotundifolia' to 'recurva'.

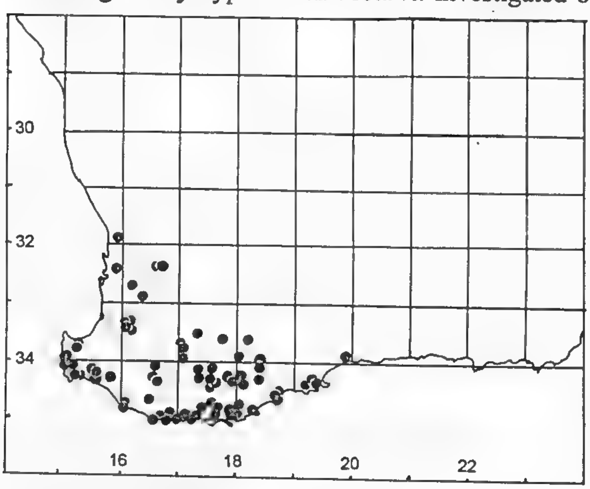
Variation

K. recurva being, next to *K. micrantha* and *K. micromera*, the species with the widest distribution, shows considerable variation, but the different forms usually remain extremely local and there are only a few characteristic of large areas.

1. The most obvious variant is a very broad-leaved form with more or less hairy branches and densely hairy inflorescences from the Stirling Range, this particular morphology might be due to some introgression with *K. montana*. It is, however, not treated as part of a hybrid swarm because of the presence of the typical recurved margin of the shiny calyx lobes characteristic of this species. Populations of this particular form that were investigated showed little variation.
2. To the south, between Albany and Bremer Bay, young branches especially when sprouting from a bud with perules usually produce delicate forward directed and more or less appressed hairs which are often also curved. These fine hairs are at least 0.5 mm long and never spreading at about right angles as in *K. rostrata*, which also has similar broad leaves.
3. Whereas leaves of the eastern forms mentioned above tend to be very broadly obovate to depressed obovate, plants from western populations usually have narrower leaves and glabrous branches.

Typification

Among the syntypes of *K. recurva* investigated only two were found to be inscribed in Schauer's handwriting, viz. *Preiss 290* (LD) and *Drummond 27* (W). While the specimens are very similar the former is here selected as the lectotype as the correction of the epithet from 'rotundifolia' to 'recurva' on that sheet indicates active work on it. Also, Schauer seem to have gleaned from that specimen 'frutex 4–5 ped., gracilis' and the detailed locality which, when provided on other specimens, is always accompanied by a reference to the publication indicating that they must have been distributed later. The Drummond specimen shows no such involvement in the drawing up of the protologue. Both specimens were probably collected in the Stirling Range, or very close to it, because they have unusually broad leaves and densely hairy inflorescences as is sometimes found in that area. They are, however, not considered part of the hybrid swarms between *K. recurva* and *K. montana* as explained above. Should future work nevertheless prove hybridity *K. spicata* must become the name for this species.



Map 3. *K. recurva* ●.

The type specimen of *K. spicata* has bracts and bracteoles, as well as the typical recurved margins of the calyx lobes as in *K. recurva* so that there seems to be little doubt that it must be a form of this species in spite of its spicate inflorescence. Elongate inflorescences are sometimes found under unusual environmental conditions, or late flowers in the season have been shown in other species to produce spicate inflorescences. Although this has not yet been recorded for *K. recurva*, the fact that no other such specimens could be found

underlines the likelihood that the type of *K. spicata* should be interpreted as an odd form of *C. recurva.*

Selection of specimens examined (129 seen)

WESTERN AUSTRALIA: *J.S. Beard 8200,* 16 miles N Kojonup, 26.x.1977 (PERTH); *R. & R. Belcher 406,* Tone River Valley along track to Mordaby from Muirs Hwy, 3.x.1967 (CANB, MEL); *B.G. Briggs NSW 124058,* Warrengup St. R., 8.x.1960 (NSW); *N.T. Burbidge 2407,* 1 ml N Boyerine Station, 10.ix.1947 (CANB); *E.M. Canning CBG 29194,* 1.1 mls Collia to Darkan, 2.x.1968, (CBG); *A.B. Cashmore 14,* near Normalup, 9.ix.1939 (PERTH); *J. Drummond 1, 132,* Swan River, s.d. (K); *A.L. Fairall 451,* Red Gum Springs, 8.x.1962 (KPBG); *D.B. Foreman 1535,* 3 km S Ambegate, 7.xii.1985 (AD, PERTH); *C.H. Gittens 1744,* Windy Harbour, -.ix.1967 (BRI, NSW); *C.A. Gardner 473,* Gnowangerup, 22.x.1920 (PERTH); *R. Helms NSW 124053,* Serpentine, 24.ix.1899 (NSW); *E.N.S. Jackson 3281,* 11 km ENE Augusta, 12.ix.1977 (AD); *Mrs McHard MEL 92792,* Blackwood-River, -.1884 (MEL); *J.H. Maiden NSW 124055,* Margaret River, -.x.1909 (NSW); *N.G. Marchant 71/703,* Cheyne Beach, 26.x.1971 (PERTH); *A. Morrison 12075,* Tenterton, 24.ix.1902 (K); *F. Mueller MEL 92757,* Heathground towards the Hay River, -.x.1967 (MEL); *E.C. Nelson ANU 17314,* Scott River east of Augusta, 21.ix.1973 (PERTH); *S.P. Pfeiffer 7,* Cheyne Beach, -.vii.1969 (PERTH); *A. & E. Priess MEL 92828,* Busselton, s.d., (MEL); *E. Pritzel 784,* District Murray, Wellington, -.x.1901 (AD, K, PERTH); *R.A. Saffrey 128,* 16 miles NE Perth, 11.ix.1964 (PERTH); *A. Strid 20888,* 3.5 km N Borden, 22.x.1982 (PERTH); *H.R. Toelken 7107,* 20 km E Karridale, 23.x.1981 (AD, PERTH); *7153,* Fitzgerald River National Park, Hamersley Drive; 5 km S Telegraph Road, 31.x.1981 (AD, PERTH); *7168,* below Toompup HS, 1.xi.1981 (AD, PERTH); *Webb MEL 92728,* Bremer River, -.1884 (MEL); *D.J.E. Whibley 5106,* 50 km W Manjimup, 6.xi.1974 (AD, PERTH); *D.J.E. Whibley 5208,* E of Mt Manypeaks, 9.xi.1974 (AD, PERTH); *J.H. Willis MEL 92680,* Chester Pass, 4.ix.1949 (MEL); *J.W. Wrigley CBG 30389,* 6 mls N Denmark, 13.x.1968 (BRI, CBG).

Putative hybrids

7(i) *K. clavata* × *K. recurva* see 6(ii) *K. clavata*

7(ii) *K. ericifolia subsp. ericifolia* × *K. recurva* see 5a(ii) *K. ericifolia* subsp. *ericifolia*

7(iii) *K. glabrescens* × *K. recurva* see 3(i) *K. glabrescens*

7(iv) *K. micrantha* subsp. *oligandra* × *K. recurva* see 12c(ii) *K. micrantha* subsp. *oligandra*

7(v) *K. micromera* × *K. recurva* see 13(vi) *K. micromera*

7(vi) *K. montana* × *K. recurva* see 1(ii) *K. montana*

7(vii) ***K. recurva* × *K. sulphurea***

This hybrid has repeatedly been recorded probably because it is easily detected on account of the obvious colour differences in the flowers of the two parent species. Field studies, however, revealed a complete range of intermediates of all the characters of the two species as well as a possible introgressional character range in *K. sulphurea.* Since pollen sterility was found to be below 10% throughout the range of the hybrids an arbitrary delimitation of the two species and the hybrid is proposed. The pink and yellow colour of the petals and stamens are sufficiently well preserved in herbarium material to allow the use of these distinctions. The absence of recurved margins of the calyx lobes and the pale pink flowers of the hybrid distinguish it from the respective parent species.

Plants of the hybrid usually occur on drier areas together with *K. recurva* but are usually obvious by their paler pink flowers and often much taller shrubs than the latter, so that one does not need to investigate their calyx lobes.

Specimens examined

WESTERN AUSTRALIA: *A.M. Ashby 2702A,* near Windy Harbour, 22.x.1968 (AD, MEL, PERTH); *B.T. Goadby s.n.,* 'King George's Sound', -.x.1898 (PERTH); *J.W. Green 1120,* ca 5 mls SW Walpole, 3.xii.1956 (PERTH); *S.W. Jackson s.n.,* Bow River, -.xii.1912 (CAMB, PERTH); *H.R. Toelken 6448,* 10 km NW Bow River bridge, 6.x.1979 (AD, PERTH); *H.R. Toelken 6453,* 2.3 km E Bow River bridge, 6.x.1979 (AD, PERTH); *7181,* 1.5 km E Bow River bridge, 2.xi.1981 (AD, PERTH); *7895,* 46 km E Manjinup on road to Mt Barker, 25.ix.1988 (AD, PERTH); *J.W. Wrigley CBG 36394,* 28 mls from Denmark to Walpole, 14.x.1968 (CBG, BRI).

8. **K. newbeyi** Toelken, *sp. nov.*

A speciebus aliis foliis oblongo-ellipticis vel -oblanceolatis plerumque longioribus 4.8 mm manifeste erosis differt.

Type: Western Australia, near Pallinup River mouth, *H.R. Toelken 7909* (*holo.*: AD; *iso.*: B, BRI, G, K, LD, MEL, MO, NSW, NY, PERTH, S, W).

Robust shrubs 0.6–1.8 (–2.3) m tall, with several ascending stems each with spreading branches, often much branched; young branches with decurrent flanges scarcely raised, more or less densely covered with short forward-directed hairs, soon becoming glabrous; early bark fibrous becoming corky-fibrous and not peeling, more or less coarsely and irregularly fluted. *Leaves: petiole* 0.9–1.4 (–1.6) mm, appressed, recurved to spreading at least in the upper part; *lamina* oblong-elliptic to -oblanceolate, (2.8–) 4.8–5.6 (–6.5) × 1.7–2 (–2.2) mm, bluntly acute or rounded, rarely acute when folded, more or less abruptly constricted into petiole, folded at least when young to cymbiform or concave later, more or less convex below, usually recurving from the upper petiole, glabrous, with horny margin crenulate to erose. *Inflorescence* a spherical botryum with (14–) 17–32 (–38) flowers, terminal on long shoots but usually not on the main branches, without subterminal clusters, rarely with terminal growth after flowering but more often growth continuing from other branches; *perules* few to many, caducous, broadly ovate, with 3–5 veins, glabrous; *bracts* broadly ovate to ovate or sometimes oblong-ovate, with somewhat hyaline margins on the upper parts of the inflorescence, 3.4–5.2 × 2.6–3.8 mm, rounded rarely bluntly acute, with 1–5 main veins, glabrous; *bracteoles* in pairs, linear-oblanceolate to obovate, 3.9–4.6 × (1.6–) 2.5–3.3 mm, rounded, more or less hooded, with broad hyaline margins, with few hairs at the base or along the central vein. *Hypanthium* 3.8–5.3 mm when flowering (free tube 2.3–2.9 mm), glabrous. *Calyx lobes* ovate-triangular, 1.7–2.2 mm long, bluntly acute or rounded, glabrous. *Corolla lobes* broadly obovate to orbicular, 3.2–4 (–4.4) mm long, shortly clawed, mid to deep pink. *Stamens* 41–48 in more than one whorl; filaments 5.1–6.9 mm long; anthers with small subterminal gland. *Ovary* with 5 locules, surmounted by a slightly broadened style base somewhat sunk into the upper surface; placenta narrowly elliptic, fleshy disc with conical attachment connected to the middle, with lobes connate mainly on the outer margins, each lobe with usually one row of ovules; ovules 10–14, spreading to pendulous and slightly longer below; style 6.5–8.1 mm long; stigma slightly broadened and often obliquely placed. *Fruit* an urceolate capsule with erect calyx lobes. *Flowers*: October (November). Fig. 8.

Distribution and ecology

Known only from a restricted area in the breakaway associations on the lower Pallinup River where it grows on dry lower slopes. Map 4.

Conservations status

Since it is known only from one small locality it would seem to be in urgent need of conservation.

Diagnostic features

A robust shrub distinguished from other species in this subsection by the oblong leaves usually being more than 4.8 mm long and having characteristic erose horny margins often also found in other species of this subsection but then less pronounced and usually restricted to young leaves.

Variation: The species showed little variation within the only population investigated.

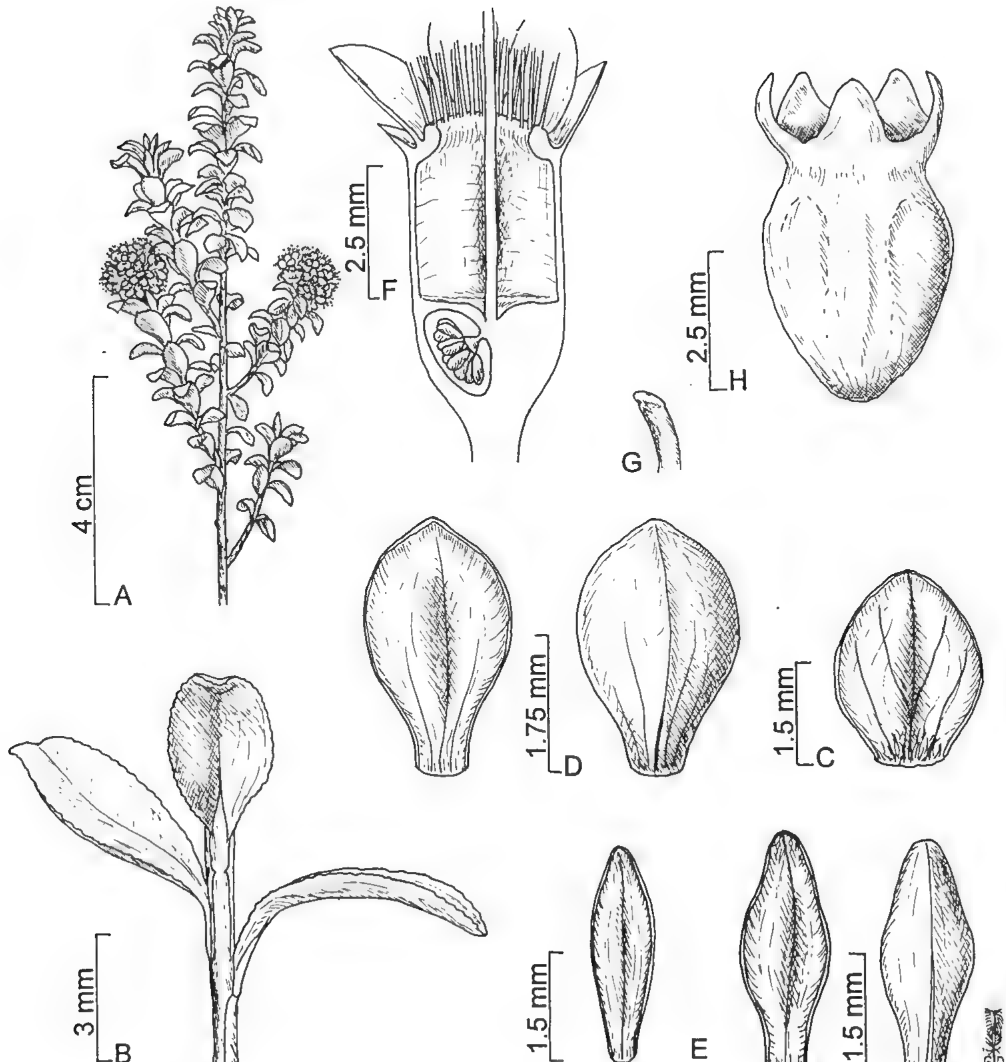


Fig. 8. *K. newbeyi* Toelken. A, flowering branch; B, branchlet; C, perule; D, bract; E, bracteoles; F, half flower; G, stigma; H, fruit. (A–H, *H.R. Toelken 7909*.)

Notes

The individual protuberances of the erose leaf margins can in this species not be shown to be derived from broadened hair bases (cf. *K. micromera*).

Etymology: The species is named in honour of Mr K. Newbey, who collected the species for the first time.

Specimens examined

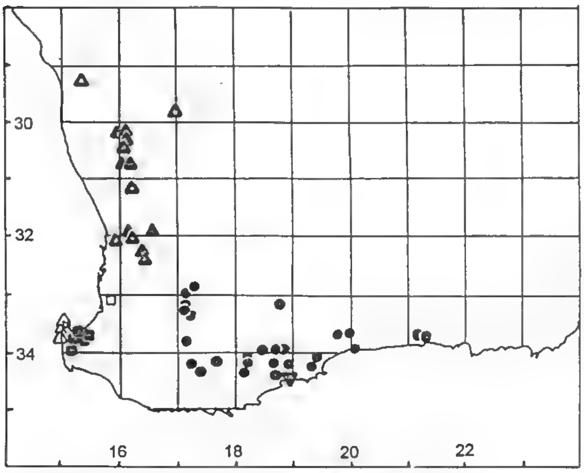
WESTERN AUSTRALIA: *E.M. Canning CBG 34442*, E Boat Harbour, 9.xi.1968 (CANB, NSW); *K. Newbey 1445*, E Boat Harbour, 18.x.1964 (PERTH); *H.R. Toelken 7909*, E Boat Harbour, 26.viii.1988 (AD, B, BRI, G, K, LD, MEL, MO, NSW, NY, PERTH, S, W).

9. K. rostrata Toelken, *sp. nov.*

K. recurva Schauer var. *melaleucoides* F. Muell. ex Benth., Fl. Austr. 3: 114 (1867), partly, as for *A.F. Oldfield s.n.*, Vasse River (K).

A speciebus aliis hujus subsectionis calicis lobis rostratis, papillis elongatis paene pilis per brevibus obtusissimis differt.

Type: Western Australia, 5 mls from Busselton towards Augusta, *J.W. Wrigley CBG 37578* (holo.: PERTH; iso.: CBG, n.v.)



Map. 4. *K. newbeyi* ▼; *K. rostrata* ■ (□ old record); *K. ciliata* △; *K. praestans* ▲; *K. micromera* ●.

Shrubs up to 1.6 m high, much branched; young branches with flanges raised but rarely decurrent for the whole length of an internode, densely covered with elongate papillae or very short erect hairs with blunt apices; early bark fibrous to fibrous-mosaic, scarcely fluted. *Leaves: petiole* (0–) 0.2–0.5 mm long, appressed; *lamina* broadly elliptic to elliptic-obovate, (1.8–) 2–2.8 (–3) × 1.8–2.3 mm, bluntly acute to rounded, sometimes mucronate, abruptly constricted into petiole, more or less flat above and below, recurved from about the middle, with distinct horny margin, glabrous. *Inflorescence* a sphaerical botryum with (5–) 11–15 (–18) flowers, terminal on usually lateral long shoots, rarely with terminal vegetative growth after flowering (dead twigs are retained for some time); *perules* few but rarely present, triangular to ovate, usually with 1 (3) veins, glabrous or with few marginal hairs; *bracts* ovate, broadly elliptic to almost orbicular, 2–2.6 × 2–2.2 mm, rounded, with one central vein, somewhat fleshy, glabrous but usually ciliolate; *bracteoles* in pairs, similar in size and shape to the bracts except sometimes spathulate-ovate, often caducous. *Hypanthium* 3.6–4 mm long when flowering (free tube 1.8–2 mm), glabrous, with vertical veins not raised. *Calyx lobes* triangular to lanceolate, 2–2.4 mm long, pointed to rostrate, ridged and usually with a subapical point, with incurved membranous margins, glabrous. *Corolla lobes* usually depressed obovate, 2.7–3.2 mm long, shortly clawed, 'rose pink'. *Stamens* 25–38 in more than one whorl; filaments 4.2–5.1 mm; anthers with a indistinct subterminal gland. *Ovary* with 5 locules, surmounted by a style slightly sunk into the upper surface; placenta narrowly elliptic, slightly fleshy, with conical attachment connected to the middle, lobes connate mainly on the outside margin, each lobe usually with one row of ovules; ovules 10 (–12) per locule, spreading to pendulous and slightly longer below; style 5–5.6 (–6.3) mm long; stigma slightly broadened with central depression. Fruit an urceolate capsule with erect calyx lobes. *Flowers*: October, November. Fig. 9.

Distribution and ecology

Known mainly from the vicinity of Busselton but also as far south as Mt Yates; one record from Harvey, north-east of Busselton, has not recently been confirmed. It has been recorded from 'peaty soil' and 'grey sandy soil'. Map 4.

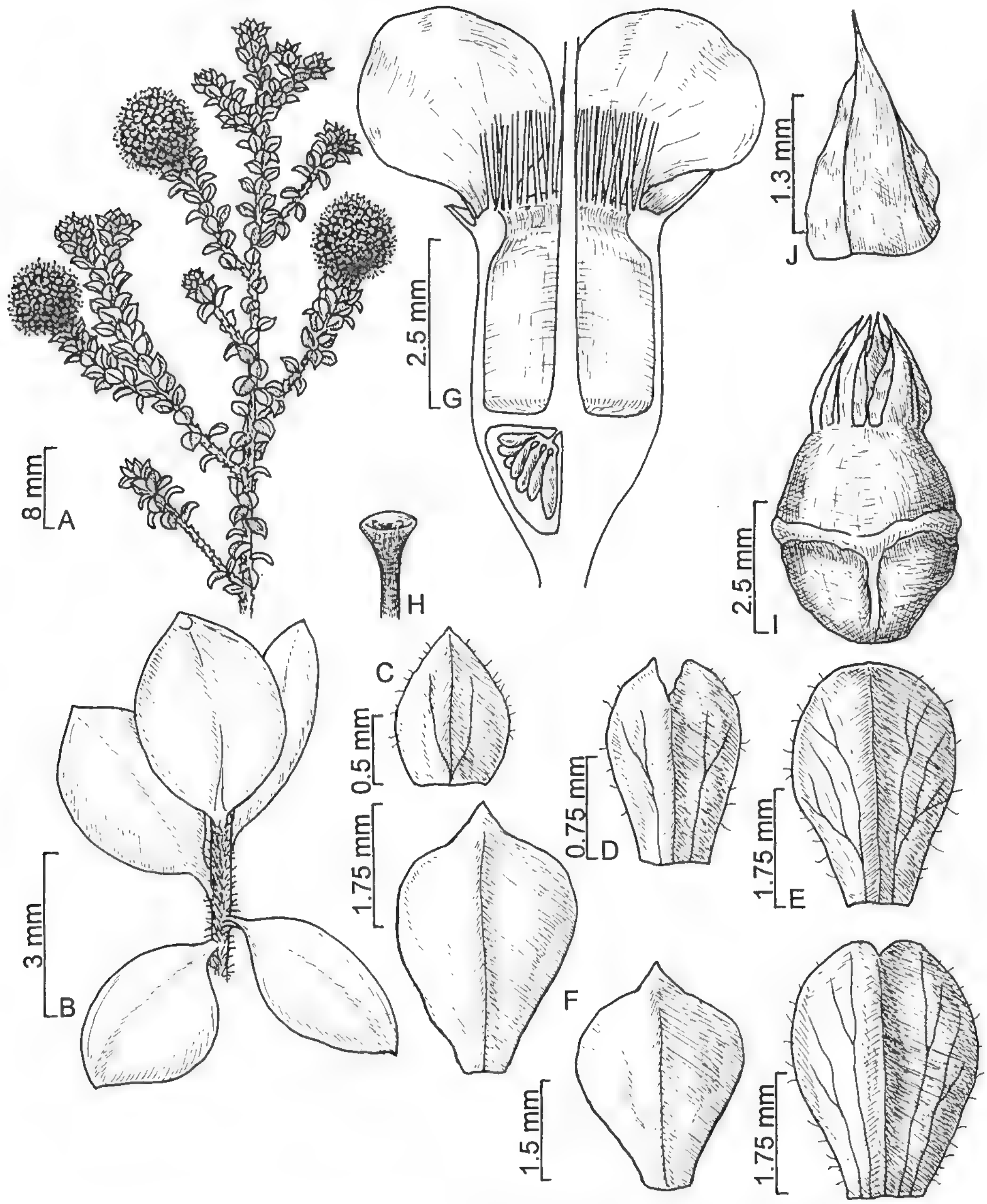


Fig. 9. ***K. rostrata*** Toelken. A, flowering branch; B, branchlet with spreading trichomes; C, perule; D, lower bract; E, upper bracts; F, bracteoles; G, half flower; H, stigma; I, fruit; J, incurved calyx lobes with menbranous margin. (A–J, *A.R. Fairall 780.*)

Conservation status

A little known species which could be endangered. It was not investigated by the author in the field.

Diagnostic features

Although in several respects it is similar to *K. recurva*, *K. rostrata* is not a hairy/papillose form of it, as it has neither the recurved margins nor the rounded apex of the calyx lobes. Their characteristicly pointed calyx lobes become more obviously beaked because the upper margins are often strongly incurved.

Etymology: The epithet 'rostrata' (beaked, Lat.) refers to pointed calyx lobes.

Specimens examined

WESTERN AUSTRALIA: *E.M. Bennett s.n.*, Busselton, -.-.1943, (PERTH); *1248*, 1 ml Metricup Road from Bussell Hwy, 20.ix.1966 (PERTH); *A.R. Fairall 780*, 142 mile peg on Augusta road, 17.x.1962 (KPBG, PERTH); *C.G. Gardner 5083*, Harvey, -.ix.1940 (PERTH); *G.J. Keighery 6830*, Mt Yates, SE Margaret River, 21.ix.1983 (PERTH); *A.F. Oldfield s.n.*, Vasse River, (K); 'nr Chuayna(?) Thicket Murchison', (K); *A. & E. Priess MEL 92742, 92836*, Busselton, s.d. (MEL); *R.D. Royce 3893*, Yoongarillup, 19.x.1952 (PERTH); *E.M. Scrymgeour 1248*, 0.9 mls on Metricup road from Busselton Hwy, 20.ix.1966, (PERTH); *J.W. Wrigley CBG 37578*, 5 mls Busselton to Augusta, 16.x.1968 (CBG, PERTH).

10. **K. ciliata** Toelken, *sp. nov.*

K. micranthae similis sed foliorum laminis ellipticis, bracteis bracteolisque lanceolatis saepe ciliatis, stigmate lato et 5 loculis quoque 9–12 ovulis differt.

Type: Western Australia, S Canal Rocks Caravan Park, *H.R. Toelken 7887* (*holo.*: AD; *iso.*: B, BRI, G, K, LE, MEL, MO, NSW, NY, PERTH, S).

Spreading shrubs (0.3–) 0.8–1.5 (–2.5) m tall, with few erect or ascending stems, much branched above young branches with flanges scarcely raised, more or less densely covered with short fine pointed hairs, soon becoming glabrous; early bark fibrous-mosaic, becoming somewhat corky and scarcely fluted. *Leaves: petiole* (0–) 0.2–0.4 (–0.6) mm long, appressed; *lamina* narrowly elliptic to elliptic-oblanceolate, (3.4–) 3.8–4.8 (–5.7) × (1–) 1.3–1.6 (–1.8) mm, bluntly acute to rounded, gradually tapering into short petiole, usually more or less flat above, usually distinctly convex below, stiffly erect, sometimes with scattered short hairs soon becoming glabrous. *Inflorescence* a spherical to elongate botryum with (9–) 12–18 (–26) flowers, terminal on mainly long shoots and rarely clustered at the apex, usually with terminal growth after flowering as well as growth unrelated to the inflorescence; *perules* often more than 5, caducous, triangular to lanceolate, acute, with one central vein, glabrous, more or less ciliate; *bracts* lanceolate to narrowly oblong-lanceolate or elliptic-oblanceolate and leaf-like, 2–3.2(–5.1) × 1–1.2 (–1.4) mm, bluntly acute, with one central vein, more or less ciliate, fleshy; *bracteoles* in pairs, similar to the bracts, rarely longer than 1.8 mm and more or less cymbiform. *Hypanthium* (2.7–) 3.2–3.8 (–4) mm long when flowering (free tube 1.9–2.3 mm long), glabrous. *Calyx lobes* triangular, (0.8–) 1–1.2 mm long, acute to pointed, rarely bluntly acute, thickened but not ridged, glabrous. *Corolla lobes* broadly obovate to orbicular, (2.9–) 3.2–3.4 mm, scarcely clawed, pink or pale pink. *Stamens* 43–48 in more than one whorl; filaments 3.7–4.9 mm long, inner ones often shorter and thinner; anthers with small subterminal gland. *Ovary* with (4) 5 locules, surmounted by a style slightly sunk into the upper surface; placenta narrowly elliptic, fleshy, abruptly constricted into centrally placed attachment, lobes mainly connate on the outer margins and each lobe with 1 or 2 rows of ovules; ovules 9–12 per locule, subequal, spreading to pendulous but scarcely longer; style 4.5–6.3 mm long; stigma distinctly broader than style but thin and with central depression. *Fruit* an urceolate capsule with spreading to somewhat erect calyx lobes. Flowers: mainly October, November but will respond quickly to favourable conditions. Fig. 10.

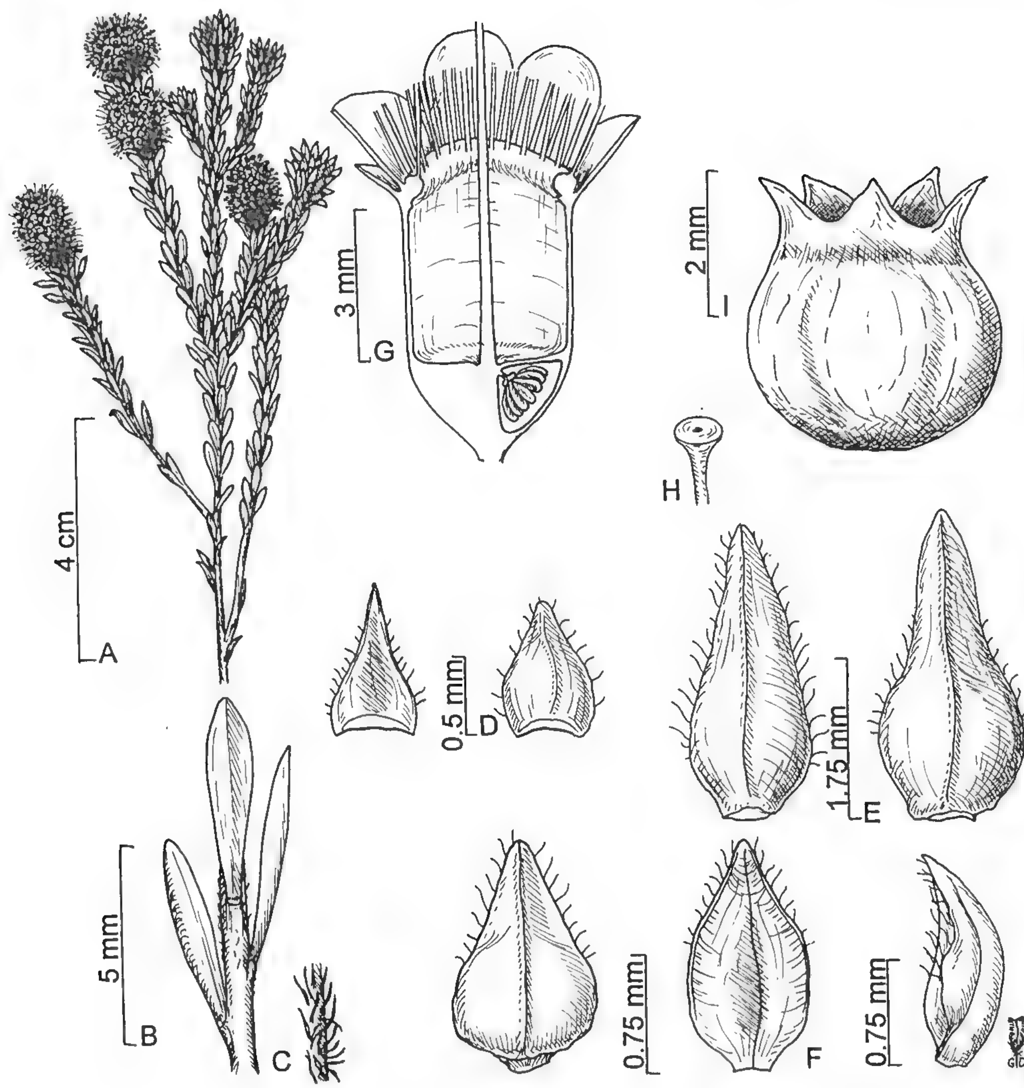


Fig. 10. *K. ciliata* Toelken. A, flowering branch; B, mature branchlet; C, section of young branchlet with pointed hairs; D, perule; E, bracts; F, bracteoles; G, half flower; H, stigma; I, fruit. (A–H, *H.R. Toelken 7887*.)

Distribution and ecology

Known only from Cape Naturaliste Peninsula to Gowaranup Bay; a record from 'between Augusta and Nannup' could not be confirmed. It is usually found on see page areas not far from the shore where it grows in association with granite or gneiss outcrops. Map 4.

Conservation status

Although observed in a number of localities it was common at none. Most of the plants are conserved since they grow in the Leeuwin-Naturaliste National Park.

Diagnostic features

Although superficially similar to *K. micrantha* it is easily distinguished by its more erect habit, fleshy leaves, and lanceolate leaf-like bracts and bracteoles. Superficially it also resembles *K. ambigua* from eastern Australia in its fleshy leaves, somewhat pointed calyx lobes particularly when young, and leaf-like bracts on often elongated inflorescences. However, the leaf venation, the slough-like abscission of the epidermis on young branches, and the small placenta with few ovules show that it belongs in section *Zeanuk*.

Etymology: The epithet '*ciliata*' (Lat.) refers to the ciliate bracts.

Specimens examined.

WESTERN AUSTRALIA; *W.E. Blackall s.n.*, between Augusta and Nannup, -.12.1930 (PERTH); *H. Demarz 3739*, Cowaranup Bay, 2.vi.1972 (KPBG, PERTH); *L.W.J. Dodd s.n.*, Canal Rocks, -.2.1968 (PERTH); *A. & E. Priess MEL 92743, 92746, 92829*, Busselton, 1870 (MEL); *H.R.Toelken 7887*, S Canal Rocks Caravan Park, 25.ix.1988 (AD, PERTH); *7890*, near Moses Rock, 25.ix.1988 (AD, PERTH); *7891*, Cowaranup Bay, 25.ix.1988 (AD, PERTH).

11. **K. praestans** Schauer in Lehm., Pl. Preiss. 1: 124 (1844).

Type: Western Australia, *J. Drummond 184* (*lecto.* — selected here: W; *isolecto.*: ?K; *syn.*: *J. Drummond 29* – now identified as *K. micrantha* subsp. *petiolata*, W; *J. Drummond 186* — now identified as *K. micrantha* subsp. *micrantha*, W; Vasse River, *Mrs Molloy s.n.*, n.v.).

K. recurva var. *praestans* (Schauer) Benth., Fl. Austr. 3: 114 (1867); Blackall & Grieve, West. Austr. Wildflow. edn 2, 3A: 98 (1980), partly.

Shrubs (0.3–) 0.6–1.5 (–2.5) m tall, with few to several erect rarely spreading stems and rigid branches, then usually much branched; young branches with decurrent flanges scarcely raised, glabrous to more or less covered with crisped or coiled appressed hairs; early bark forming a fibrous mosaic, later fibrous to peeling in long strips, scarcely fluted. *Leaves: petiole* usually absent and main vein not bulging; *lamina* oblong-oblanceolate rarely -obovate, (3.4–) 4.5–6.8 (–11.2) × (1.3–) 1.8–2.5 (–3.4) mm, usually rounded, rarely with dorsal mucro, with long cuneate base tapering in a straight line from the broadest point to the base, usually with a sharp edge throughout, flat to slightly convex particularly below, stiffly erect and slightly curved outward from the base, rarely with apex slightly recurved, glabrous. *Inflorescence* an almost spherical to hemispherical botryum (usually broader than long in flower) with (8–) 14–20 (–30) flowers, terminal on short and long shoots and often clustered at the end of branches, with terminal growth at least on the long shoots; *perules* usually less than 5, caducous when flowering, oblong-ovate to ovate, usually with 1 vein, glabrous to densely hairy; *bracts* ovate to oblong-ovate or rarely ovate-spathulate on upper parts of the inflorescence, 3.5–4.2 × 2.1–2.5 mm, bluntly acute to rounded, boat-shaped, with some marginal hairs and hairs along the central vein dorsally to densely hairy; *bracteoles* in pairs, linear-oblanceolate to -elliptic, 3.3–4 × 1.2–2 mm, acute or bluntly acute, with more or less hyaline margin, with few to many usually crisped hairs mainly along the central vein dorsally. *Hypanthium* (3.6–) 3.8–5.8 mm long when flowering (free tube 2.4–3.3 mm), glabrous to densely covered with crisped hairs. *Calyx lobes* ovate, 1.4–1.8 mm, rounded or bluntly acute, often appearing acute because of incurved margins, glabrous. *Corolla lobes* depressed obovate, 2.8–3.6 × (2.7–) 3.1–3.8 (–4.4) mm, scarcely clawed, usually deep pink to rose. *Stamens* (50-) 70–90 (–106) in more than one whorl; filaments (4.8–) 5.1–6.2 mm; anthers with small almost terminal gland. *Ovary* with 5 locules, surmounted by a broadened style base slightly sunk into the upper surface; placenta an elliptic, scarcely fleshy disc with conical attachment connected to the middle, lobes connate mainly on the outside margin, each lobe with two rows of ovules; ovules (8–) 10–14 (–15), spreading or lowest ones pendulous and slightly longer; style 5.5–7.7 mm long;

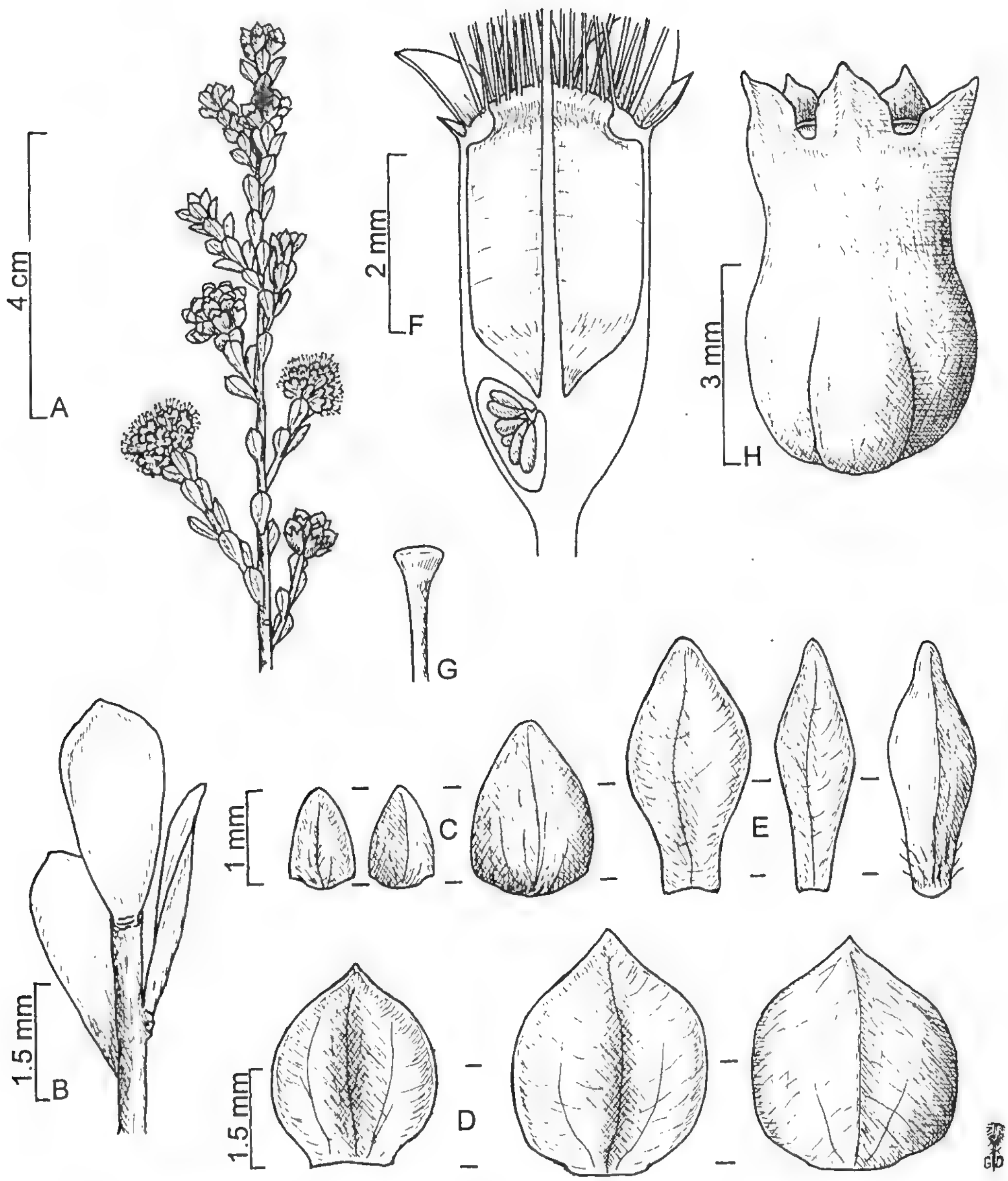


Fig. 11. ***K. praestans*** Schauer. A, flowering branch; B, branchlet; C, perules; D, bracts; E, bracteoles; F, half flower, G, stigma; H, fruit. (A–G, *H.R. Toelken 7112*; H, *D.J.E. Whibley 4887*.)

stigma distinctly broader than style. Fruit an urceolate capsule with erect calyx lobes. *Flowers*: September, October (November). Fig. 11.

Distribution and ecology

This species has been mainly recorded from gravelly slopes of the low mountain ranges, mainly the Darling Ranges, adjoining the coastal plains. Sometimes it has also been recorded from depressions in inland localities such as, near Moora. It is found in a broad triangle mainly along the escarpment from near Minginew in the north to near Wubin in the east and Mt Coke in the south. Map 4.

Conservation status

Although recorded from a wide area, *K. praestans* where found, is not common; it is conserved in a number of national parks.

Diagnostic features

This species is unique among broad-leaved species because the stiffly erect leaves have a long cuneate base tapering in a straight line from the broadest point near the apex to the base. The green tissue of the lamina usually continues to the base and the central vein, though visible at the base, does not bulge as is usually found in the petiole of other species. The petals are also broader, (2.5–) 3-5 mm, than in either *K. micrantha* subsp. *micrantha* or subsp. *petiolata.*

Variation

Plants from the northern parts of the distribution are hairy to tomentose on most parts including the hypanthium, while further south the plants tend to be glabrous. Specimens from near Perth tend have a more recurved apex of the leaves even when they are young than do plants from other areas. The leaf lamina of the southern form often does not continue its green tissue to the base although it is distinctly ridged, and the broadest point is often on the upper third whereas it is on the upper fifth or eighth of the lamina in the northern form.

Typification

The name *K. praestans* seems to be based on four specimens, viz. three *J. Drummond* specimens (W) annotated by Schauer and a specimen of *Mrs Molloy* from Vasse River, which has not yet been located. The last one should probably be excluded because *K. praestans*, as lectotypified, has not been recorded so far south. However, the three Drummond specimens also each belong to a different species and a case could be made for each of them being specificly referred to in the protoloque. It seems that Schauer's description was kept intensionally broad so as to accommodate all the specimens seen. Accordingly the one specimen, *J. Drummond 184*, was selected as the lectotype of *K. praestans*, while the other specimens are identified as follows:

J. Drummond 29 as *K. micrantha* subsp. *petiolata; J. Drummond 186* as *K. micrantha* subsp. *micrantha*; *Mrs Molloy*, Vasse River as probably either *K. micrantha* subsp. *micrantha* or *K. rostrata.*

Selection of specimens examined (41 seen)

WESTERN AUSTRALIA: *A.M. Ashby 2654*, Cairn Hill near Gunyidi, 2.x.1968 (AD, PERTH); *W.E. Blackall 2551*, between Moora and Watheroo, 13.ix.1932 (PERTH); *E.M. Canning CBG 28968*, 100.6 miles Perth to Moora, 29.ix.1968 (CANB, PERTH); *R.J. Cranfield 4233*, 15 km N of South Bindoon, 19.ix.1983 (PERTH); *J. Drummond MEL 92867*, Western Australia, s.dat. (MEL); *H. Eichler 15790*, C. 5 km NW Gleneagle, 29.viii.1959 (AD); *C.A. Gardner s.n.*, Coomberdale, ix.1963 (PERTH); *F. Lullfitz 5921*, 62 mile peg on Great Northern Highway, 22.x.1964 (PERTH); *J.H. Maiden s.n.*, Mingenew, x.1909 (BRI 273818, NSW); *F. Mueller MEL 92822*, Western Australia, s.d. (MEL); *M.E. Phillips 1934*, 40 miles S Perth along Albany Highway, 30.ix.1968 (CANB); *E.M. Scrymgeour 1358*, 125 miles Perth-Geraldton Rd, 29.ix.1966 (PERTH); *J. Seabrook 179*, Helena Valley, 3.ix.1977 (PERTH); *H.R. Toelken 7110*, 5 km N Mundorin Weir wall, 25.x.1987 (AD, PERTH); *7112*, below Glen Eagles picnic area, 27.x.1981 (PERTH); *D.J.E. Whibley 4887*, 15 km N Moora, 2.xi.1974 (AD); *E. Wittwer 812*, 6 miles N Watheroo, 4.ix.1969 (KPBG, PERTH).

Putative hybrid

11(i) *K. micrantha* subsp. *petiolata* × *K. praestans* see 12b(i) *K. micrantha* subsp. *petiolata.*

12. **K. micrantha** Schauer in Lehm., Pl. Preiss. 1: 125 (1844); 2: 223 (1848); Benth., Fl. Austr. 3: 112 (1867); Domin, Mém. Soc. Sci. Bohême (1921) 22, 2: 86 (1923), as 'micrandra', partly; Blackall & Grieve, West. Austr. Wildfow. edn 1, 1: 293 (1954); Beard, West Austr. Pl. edn 2, 76 (1970); Blackall & Grieve, West. Austr. Wildflow. edn 2, 3A: 98 (1980); J. Green, Census Vasc. Pl. West. Austr. edn 2, 128 (1985); Rye in N.G. Marchant et al., Fl. Perth Region l: 410 (1987).

Type: Western Australia, near Guildford, *J.A.L. Preiss 277* (*lecto.* — selected here: LD; *isolecto.*: G, MEL 92409, W).

Shrubs 0.25–1.2 (–2) m tall, usually with many spreading stems, little to moderately branched, with ultimate branches thin and wiry or rarely rigid; young branches with decurrent flanges scarcely raised, glabrous to more or less hairy with short appressed straight hairs, soon becoming glabrous; early bark splitting into slender strips, slightly peeling, becoming shallowly fluted and somewhat corky. *Leaves: petioles* (0.2–) 0.4–0.7 (–1) mm long, appressed at first then spreading to slightly recurved at least towards the apex; *lamina* linear-oblanceolate, oblanceolate or rarely obovate, (0.8–)1.3–6.5 (–7.8) × (0.4–) 0.6–2 (–3.2) mm, acute to cuspidate, rarely truncate and mucronate with apex more or less recurved at least when young, with cuneate base often long, slender and then abruptly constricted into bulging petiole, flat to slightly concave above, slightly convex below, older ones often recurved from the middle, glabrous or rarely with scattered hairs, soon becoming glabrous. *Inflorescence* a spherical to oblong botryum with (11–) 20–38 (–50) flowers being usually curved on the lower parts of the inflorescence, terminal mainly on long shoots, rarely clustered at the end of branches, sometimes with limited terminal growth after flowering while growth continues from major shoots; *perules* up to 5, usually caducous at flowering, ovate to oblong-ovate, usually with 1 vein, with a few hairs and/or marginal cilia; bracts ovate to commonly oblong-ovate or oblanceolate or rarely obovate, (1.4–) 1.6–2.7 (–3.3) × (0.8–) 0.9–1.4 mm, rounded to bluntly acute or cuspidate, curved, not keeled, central vein often raised to the apex at least on lower parts of the inflorescence, with scattered hairs to glabrous; *bracteoles* in pairs, linear-oblanceolate, 1.5–2.8 (–3.1) × 0.6–1.2 mm, rounded to truncate, with membranous to hyaline margin, with few scattered hairs or rarely marginal cilia to quite glabrous. *Hypanthium* 2.1–3.1 (–3.6) mm long when flowering (free tube 1.8–2.3 mm), typically curved (or almost straight in subsp. *petiolata*) on flowers of the the lower part of the inflorescence, glabrous. *Calyx lobes* ovate to ovate-triangular, 0.8–1 (–1.2) mm long, acute to bluntly acute, rarely pointed, with margins more or less incurved, glabrous. *Corolla lobes* oblanceolate- to obovate-spathulate, 1.4–1.8 (–2.5) × (1.3–) 1.5–1.8 (–2) mm, clawed, pink to white, rarely purple. *Stamens* (8–) 12–40 (–60) in more than one whorl; filaments 2.4–3.6 mm long; anthers with small subterminal gland. *Ovary* with 2 or 3 (–5) locules, surmounted by a slender style slightly or not sunk into the upper surface; placenta elliptic, scarcely fleshy disc with slender attachment connected to the upper half, small lobes mainly connate on the outer margins, each lobe with one row of ovules; ovules 2–6 (–14) per locule, more or less pendulous and elongate or at least the lowermost; style 2.9–4.1 mm long, stigma usually scarcely broader than style. *Fruit* an urceolate capsule with erect or incurved calyx lobes.

Variation

This very variable and widespread species complex is neither always easily distinguished from *K. praestans* and *K. micromera* on its northern and south-eastern end of its distribution nor does it lend itself to a clear delimitation into easily recognised taxa. The frame work provided here requires much more field work.

In the south-east the distributions of *K. micrantha* subsp. *oligandra* and *K. micromera* overlap in large areas. The latter is, though superficially very similar, usually readily distinguished by the broad green erect calyx lobes on its fruits and the ovary always being 5-loculed.

K. praestans, whose distribution borders onto *K. micrantha* subsp. *petiolata* north to north-east of Perth, is mainly distinguished because most of its sessile leaves have margins tapering in a straight line to its base, a phenomenon only rarely found on odd leaves of *K. micrantha*. This distinction is usually supported by the greater number of stamens (50–106) and broader petals (2.5–5 mm) in *K. praestans*.

However, *K. micrantha* subsp. *petiolata* appears intermediate in most characters between *K. micrantha* subsp. *micrantha* and *K. praestans* and occurs in the area between these two taxa. The perplexing thing about the variation observed is that *K. micrantha* subsp. *petiolata* is exceptionally variable and, because of its intermediate nature, one is tempted to interpret the variation as being due to hybridisation. Analysing this variation one observes, however, a clinal range orientated largely in a north to south direction, from 5 locules per ovary, each locule with 7–9 ovules near Jurien Bay to (2) 3 locules each with 2–4 ovules north of Perth. The latter condition is that also found in typical *K. micrantha* which is found in similar habitats along the coast southwards, but distinguished by its curved hypathium with veins being visible to the apex of the calyx lobes. Most plants of subsp. *micrantha* have a glabrous floral axis except for the stipuline trichomes, while they are densely hairy in subsp. *petiolata*. This apparent a cline has an extraordinary multiplicity of character changes from *K. praestans* to *K. micrantha* subsp. *petiolata* and then subsp. *micrantha*. Hybridisation could account for some local variation but only one population could be identified as such (cf. *H.R. Toelken 7109*: *K. micrantha* subsp. *petiolata* × *K. praestans*), so that the full significance of hybridisation on the variation found is not known. The intermediate character of this subspecies however, is not attributed to hybridisation, because one would expect much more variation due to backcrossing with *K. praestans*, but no plants of this species have been recorded from the swamps of the coastal plains. *Kunzea praestans* also shows little variation that could be related to hybridisation with *K. micrantha* subsp. *petiolata*.

In spite of its close resemblance to *K. micrantha, K. praestans* is here given species rank because it usually grows in dryer habitats often on dry gravelly slopes, unlike *K. micrantha*, which is throughout its range associated with wet or temporary marshy conditions. The apparent character gradient between the two species described above is not geographically in a single line, i.e. plants of subsp. *petiolata* from near Jurien Bay show closest similarity to those of *K. praestans* from south of the Swan River, so that their close resemblance probably to be explained by derivation from a common ancestor rather than from one another. Two unusual records from the Wongan Hills (*E.H. Ising AD 966030679*, *F.W. Went 198* – PERTH) must, according to their leaves, narrow petals and small placenta, be identified as *K. micrantha* subsp. *petiolata*, but they have (10–) 12–14 ovules per locule and occur well outside the distribution area of that taxon. This possible relic population seems also to indicate that the two taxa are derived from a common ancestor.

The transition from subsp. *petiolata* into subsp. *micrantha* is not clear from the few populations remaining in the area around the lower Swan River now occupied by the cities of Perth and Fremantle. It seems significant that a botanically observant collector like J. Drummond considered it appropriate to include specimens of all three taxa (*K. praestans, K. micrantha* subsp. *petiolata* and subsp. *micrantha* cf. typification of *K. praestans*) in what seem to be his first collection of Western Australian plants sent to J.D. Hooker in the early 1840s, and which Schauer (1844) included under *K. praestans* although he described *K. micrantha* in the same publication.

Kunzea micrantha subsp. *micrantha* is found from Perth to around Bunbury, while the closest occurrence of subsp. *oligandra* is of small populations in forested areas east of Manjimup. The calyx lobes of the specimens of these western populations are often bluntly acute and the flowers have more than fifteen stamens, while in the eastern populations the flowers often have fewer than 15. Their calyx lobes are usually rounded and become incurved after flowering.

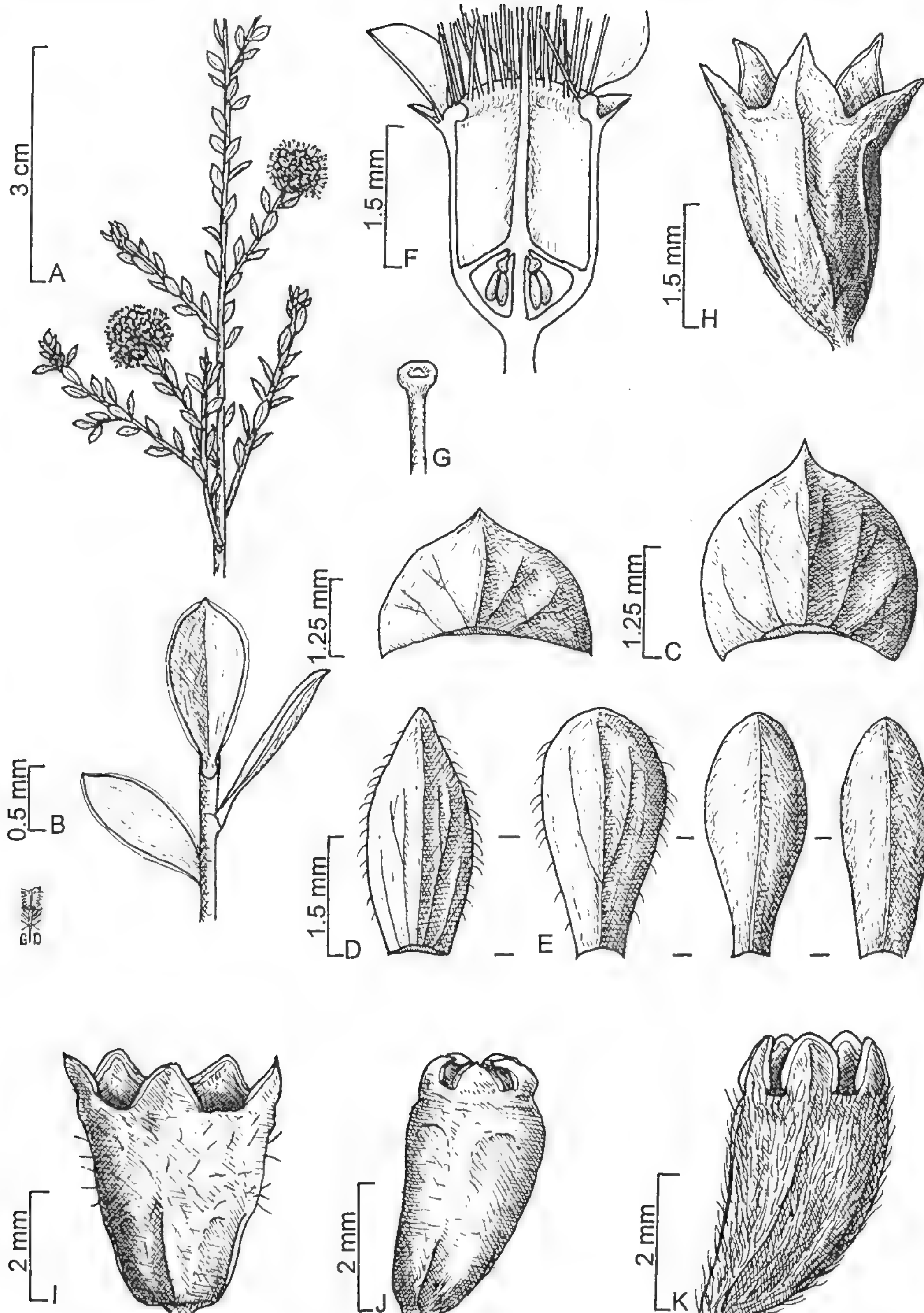


Fig. 12. *K. micrantha* Schauer subsp. ***micrantha***. A, flowering branch; B, branchlet; C, perule; D, bract; E, bracteoles; F, half flower; G, stigma; H, immature fruit. – subsp. ***petiolata*** Toelken. I, immature fruit. – subsp. ***oligandra*** (Turcz.)Toelken. J, immature fruit. – subsp. ***hirtiflora*** Toelken. K, immature fruit. (A–G, *H.R. Toelken 7105*; H, *W.E. Blackall s.n.*, -.xii.1930; I. *M.E. Phillips CBG28468*; J, *H.R. Toelken 7113*; K, *H.R. Toelken 7899*.)

Since numerous stamens and many ovules in each of the 5 locules are considered primitive characters in *Kunzea* the progressive reduction southwards and then eastwards indicates a direction of evolutional development of the taxa of *K. micrantha*. The subsp. *hirtiflora* must represent an early segregate in the development of subsp. *oligandra* that has become extremely localised.

Typification and nomenclature

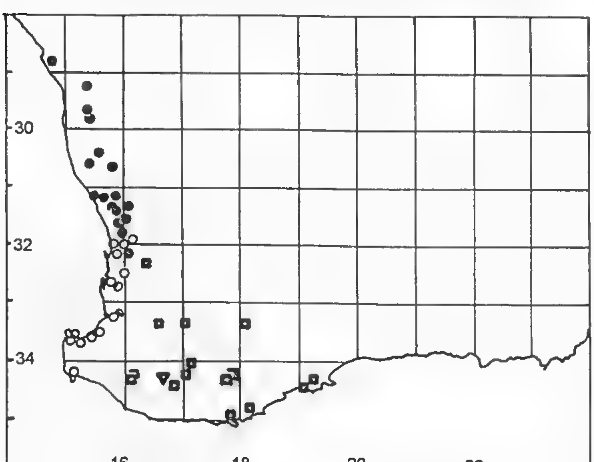
Although Schauer annotated only one specimen in what seems to have been Lehmann's herbarium (now in LD) this does not prove that he had only used that specimen from which to draw up the description. Since there is some uncertainty when authors examined the Preiss specimens i.e. before or after duplicates were distributed (K.L. Wilson 1983), the specimen selected here as a lectotype might be shown by future research to be the only specimen he saw at the time, i.e. the holotype (cf. introdution).

As no infraspecific taxa have been recognised since Bentham (1867), references to *K. micrantha* in most previous literature are cited under the species name because it is difficult to assess with certainty what different elements individual authors had included in their treatment.

13a. subsp. **micrantha.**

Kunzea micrantha Schauer in Lehm., Pl. Preiss. 1: 125 (1844).

Shrublets 0.3–1.5 (–2) m tall, with few erect wiry woody branches, sparsely and usually untidily branched. *Inflorescence* with 25–35 (–40) flowers, with axis usually glabrous, rarely sparsely to densely hairy so that stipuline trichomes are often not visible; *lower bracts* oblong-lanceolate to -oblanceolate, rounded rarely bluntly acute, with central vein scarcely raised, with or without hairs at the base. *Hypanthium* of lower flowers curved, with raised veins visible to the apex of the calyx lobes, as long as or longer than bracts. *Calyx lobes* ovate, often becoming triangular with incurved margins, usually acute, remaining more or less erect after flowering. *Stamens* 18–35. *Ovary* with (2) 3 locules each with 2, 3 (4) ovules. *Flowers*: (August) September, October. Fig. 12A–H.



Map 5. *K. micrantha* subsp. *micrantha* O; subsp. *petiolata* ●; subsp. *oligandra* ◘; subsp. *hirtiflora* ▼.

Distribution and ecology

Growing in temporary marshes usually with clay soil along the coastal plains from near Perth to the vicinity of Busselton, and apparently sporadically to near Augusta. Map 5.

Conservation status

Recorded from a wide area but all populations are small because of a limited number of swamps without tree canopy. It needs to be monitored to ensure conserving significant populations.

Diagnostic features

The acute, stiffly erect calyx lobes as well the distinctive raised veins to the apex of these lobes on the curved lower flowers are characteristics of this subspecies.

Variation

In northern populations the bracts and bracteoles are shorter than the hypanthium and the floral axis is densely hairy; they become respectively gradually longer and less hairy to the south. Although these changes do not seem to be linked they occur so gradually that they appear to be part of a clinal development and no meaningful taxonomic separation between the northern and southern populations could be effected.

Some specimens east of Bunbury sometimes have broad calyx lobes that resemble those of subsp. *oligandra*, however, they are spreading, and not incurved to cover up the inside of the hypanthium as in that subspecies.

In the vicinity of Busselton the calyx lobes show considerable variation from acute and often without obvious raised veins to pointed and often with a dorsal subapical point (also on the leaves) reminiscent of those of *K. rostrata*, but there is no other evidence to suggest that these are hybrids with the latter species.

Selection of specimens examined (69 seen)

WESTERN AUSTRALIA: *R. & R. Belcher 164*, Waterloo, 12 mls E Bunbury, 30.ix.1967 (MEL, PERTH); *W.E. Blackall s.n.*, near Augusta, -.xii.1930 (PERTH); *M.G. Corrick 9*, Mt Dale Road, SE Carinyah, 6.xi.1983 (AD); *H. Demarz 11404*, Kenwick swamp, 9.x.1986 (PERTH); *J. Drummond 2, 133*, Western Australia, -.-.1843 (BM, K, MEL); *C.A. Gardner s.n.*, Busselton, 27.ix.1944 (PERTH); *R. Helms s.n.*, Guildford, 15.x.1897 (PERTH); *G.J. Keighery 1032*, Ruabon, 17.ix.1977 (PERTH); *1837*, Ellen Brook Tortoise Reserve, 19.x.1978 (KPBG); *M. Koch 2650*, Picton Junction, -.xii.1922 (MEL); *A.H.S. Lucas NSW 124011*, -.x.1928 (NSW); *Mrs McHard MEL 92722*, Blackwood River, -.-.1882 (MEL); *J.H. Maiden NSW 124008*, Welshpool to Kalamunda, ix.1909 (NSW); *A. Morrison s.n.*, Kelmscott, 11.ix.1817 (CANB, MEL, PERTH); *8120 & 8121*, lower Vasse River, 22.iii.1898 (K); *F. Mueller MEL 92818*, Serpentine River, 1.xii.1877 (MEL); *F. Mueller MEL 92834*, Prestons River, 5.xii.1877 (MEL); *A. & E. Priess MEL 92820*, Busselton, s.d. (MEL); *J.M. Powell 3039*, 2.9 km N Dunsborough, 8.xi.1985 (AD); *R.D. Royce 2633*, Welshpool road, Busselton, 15.ix.1948 (PERTH); *R.D. Royce 2673*, Capel, 24.ix.1948 (PERTH); *Sargent & C.A. Gardner 695*, Picton Junction, x.1920 (PERTH); *A. Steffanoni ADW 16087*, Gosnells, 18.ix.1927 (AD); *F. Stoward NSW 124006*, Serpentine, -.x.1911 (NSW); *H.R. Toelken 6441*, 4 km W Coolup Station, 4.x.1979 (AD, PERTH); *W. Webb MEL 92715*, Upper Blackwood River, -.-.1893 (MEL); *J.H. Willis MEL 92682*, North Dandalup, 10.ix.1947 (MEL); *Wilson & Herbert s.n.*, North Dandalup, -.xi.1920 (PERTH).

12b. subsp. **petiolata** Toelken, *subsp. nov.*

K. praestans Schauer in Lehm., Pl. Preiss. 1: 124 (1844), partly, as for *J. Drummond 29*.

K. praestanti similis sed laminis foliorum abrupte constrictis ad petiolos tumescentes, hypanthiis brevioribus staminibusque (30–) 35–45 (–60) differt.

K. micranthae subsp. *micranthae* similis sed hypanthio recto et sine venis prominentibus ad apices obtusos loborum calicis differt.

Type: Western Australia, 23 mls from Jurien Bay to Moora, *M.E. Phillips CBG 26892* (holo.: CANB; iso.: NSW).

Shrublets (0.6–) 1–1.5 (–2) m tall, with erect to spreading, usually with rigidly woody branches, much branched. *Inflorescence* with (11–) 15–24 (–35) flowers, axis hairy so that stipuline trichomes are not visible; *lower bracts* obovate, obtuse to rounded. *Hypanthium* with raised veins but not visible or incompletely visible on calyx lobes, straight, usually longer than bracts. *Calyx lobes* ovate to ovate-triangular, with slightly incurved margins, usually bluntly acute, remaining erect after flowering. *Stamens* (30–) 35–50 (–60). *Ovary* with 3, 4 (–5) locules each with 4–10 (–14) ovules. *Flowers*: September, October (November). Fig. 12I.

Distribution and ecology

Usually growing in clay depressions with temporary swampy conditions on the coastal plains from just north of the Swan River to near Jurien Bay. Map 5.

Conservation status

Widespread and locally frequent but needs to be closely monitored because of a reduction of localities due to urban and agricultural development.

Diagnostic features

Kunzea micrantha subsp. *petiolata* is distinguished from subsp. *micrantha* by its straight (not curved) hypanthium without or with only faint veins visible up to the apex of the calyx lobes, while *K. praestans* is distinguished by the long-cuneate base of its leaf lamina with the margins usually continued in a straight line to the base and without a petiole. Occasionally the latter distinction needs to be supported by the supplementary character of petals being 1.8–2.2 (–2.5) mm broad in subsp. *petiolata*, while they are (2.5–) 2.8–4 (–5) mm broad in *K. praestans*, which has usually also more than 60 stamens.

Variation

The subsp. *petiolata* includes much local variation which is not clearly understood because it grew in an area now largely occupied by the urban development of Perth and Fremantle as discussed under the species.

Typification

A specimen from near Jurien Bay was chosen as the type although it might prove to be an extreme form. The southern more common forms were avoided because they were more likely to be involved in hybrid swarms. The northern form seems to be more or less isolated geographically from subsp. *micrantha* and *K. praestans*, as no specimens of those taxa from near Jurien Bay have been seen.

Etymology: The epithet '*petiolata*' (Lat.) refers to the presence of a petiole on leaves in contrast to its absence on leaves of the very similar *K. praestans*.

Specimens examined (45 seen)

WESTERN AUSTRALIA: *N. Byrnes 3970*, 11 km N Gingin, 2.x.1980 (BRI); *J.B. Cleland NSW 124049*, York, -.xii.1907 (NSW); *D. Churchill s.n.*, Chittering, 6.x.1954 (PERTH); *R. Coveny 3095*, 19.3 km NE Bullsbrook, 29.viii.1970 (NSW, PERTH); *R.J. Cranfield 5040*, Muchea Townsite, along Carl Street, 6.xi.1984 (PERTH); *L.A. Craven & C. Chapman 6884*, 3 km S Three Springs, 2.x.1981 (PERTH); *A.S. George 1692*, 31 mls N Perth, 28.x.1960 (PERTH); *J.W. Green 5465*, 24 km E Eneabba on E boundry of Tathra National Park, 17.ix.1981 (PERTH); *R.J. Hnatiuk 780163*, 10 km N Mullering Brook, 17.x.1978 (PERTH); *780164*, ca 10 km N Mullering Brook, 17.x.1978 (PERTH); *790034*, ca 8 km S Gingin, 27.ix.1979 (PERTH); *E.H. Ising AD 966030679*, Wongan Hills, 13.ix.1926 (AD); *G.J. Keighery 5252*, Serpentine, 29.ix.1982 (PERTH); *F. Lullfitz 5612*, 11.1 mls S Gingin Cemetery, 22.x.1960 (KPBG, PERTH); *F. Mueller MEL 92832*, Upper Irwin River, -.xi.1877 (MEL); *M.E. Phillips CBG 28458*, 10 mls from Gingin to Regans Ford, 28.ix.1968 (CANB, MEL, NSW); *R.D. Royce 9453*, Moore River National Park, 2.x.1971 (PERTH); *Miss Julia Sewell MEL 92801, MEL 92848*, Upper Swan River, 1885 (MEL); *E.M. Scrymgeour 559*, Cannington Swamp, 3.ix.1966 (PERTH); *A. Strid 20653*, 1.5 km N Bullsbrook, 30.ix.1982 (B, G, PERTH); *F.W. Went 198*, between Wubin and Wongan Hills, 10.ix.1962 (PERTH); *P.G. Wilson 3794*, 13 km WNW Badgingarra, 1.xi.1965 (MEL, PERTH); *T. & J. Whaite W21*, Geraldton area, 22.ix.1976 (NSW); *D.J.E. Whibley 3204*, 15 km W Moora on road to Dandaragan, 8.x.1969 (AD); *C.T. White 5201*, between Darlington and Bellevue, 1.xi.1927 (BRI).

Putative hybrid

12b(i) ***K. micrantha*** subsp. ***petiolata*** × ***K. praestans***

Specimens with the leaf lamina continued in a straight line to the base can be separated as *K. praetans*, but all the others are included in *K. micrantha* subsp. *petiolata*, a subspecies not clearly separable from this hybrid (cf. variation above), which is mainly distinguished by its somewhat broader petals (2–2.6 mm).

A similar wide variation of plants has been recorded from the vicinity of Gingin, which is also situated close to the escarpment, but no population studies have been conducted in that area.

Specimen examined

WESTERN AUSTRALIA: 3 km N Stoneville Post Office, *H.R. Toelken 7109* (AD — mass collection).

12c. subsp. **oligandra** (Turcz.) Toelken, *comb. nov. et stat. nov.*

K. oligandra Turcz., Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Pétersbourg 10: 336 (1852); F. Muell., Fragm. 8: 183 (1874).

Type: Western Australia, *J. Drummond 5, 139* (*holo.*: KW - PERTH, photo.; *iso.*: BM, K (2×), MEL 92410, NSW, PERTH).

K. micrantha auct. non Schauer: Benth., Fl. Austr. 3 : 112 (1867), partly, as for *J. Drummond 5, 139*, and *G. Maxwell s.n.*, Salt River (K).

Shrubs up to 0.6 m tall, with several woody spreading stems from the base. *Inflorescence* with 25–48 flowers, axis glabrous except for the bristle-like stipuline trichomes; *lower bracts* obovate, cuspidate to mucronate, with central vein more or less raised to the apex, with few long hairs towards the base. *Hypanthium* of lower flowers curved, with raised veins to the base of the calyx lobes, distinctly shorter than bracts. *Calyx lobes* ovate, bluntly acute to rarely rounded, with papillose surface greyish-green, incurved and more or less closing flower after flowering. *Stamens* 7–14 (–20). *Ovary* with 2 (3) locules each with 2, 3 (4) ovules. *Flowers*: (August) September, October. Fig. 12J.

Distribution and ecology

Growing in temporary marshy depressions and often partly submerged when flowering. It is found in a broad belt mainly inland from the southern coast of south-western Western Australia from near Manjimup to Porongorup and again near Bremer Bay. Map 5.

Conservation status

More observations are required as this widespread subspecies is never common and only small populations are conserved in the Stirling Range National Park and in the south-western part of the Fitzgerald River National Park.

Diagnostic features

The subsp. *oligandra* is easily recognised by the broad greyish calyx lobes, which are incurved after flowering so as to close the hypanthium. The raised veins on the hypanthium, typical of *K. micrantha*, do not continue to the apex of the calyx lobes so that *K. micromera* is mainly distinguished from the above subspecies by its widely spaced short calyx lobes which usually remain stiffly erect after flowering, the bulging hypanthium immediately above the ovary, and its five locules per ovary.

Although the bracts and bracteoles of subsp. *oligandra* might bear a few scattered hairs along the margins of the central vein dorsally, the floral axis is without hairs, and if hairy, the plant is interpreted here as one of the following two hybrids, but this interpretation requires more field studies before it can be confirmed: (a) *K. micrantha* subsp. *oligantha* × *K. micromera* with very short hairs about as long as the stipuline bristles or (b) *K. micrantha* subsp. *oligantha* × *K. recurva* with longer hairs and thick rigid branches.

Variation

This subspecies is incompletely known probably because it is never as common as the typical one and consequently fewer specimens were available for this study. Hence also the variation and the delimitation of the putative hybrids are not clearly understood.

While the number of stamens in populations from eastern localities tend to be fewer than 15 per flower they are often up to 20 in western populations. Here this subspecies is distinguished from subsp. *micrantha* only by the broad greyish calyx lobes which are incurved after flowering.

Typification

Turczaninov described *K. oligandra* as having three locules per flower, however, this has been found to be the exception even in isotypes of *J. Drummond 5, 139.* Most of the specimens examined have two locules.

Specimens examined

WESTERN AUSTRALIA: *C. Andrews s.n.*, near Albany, -.x.1900 (PERTH); *A.M. Ashby 2010*, W Rocky Gully, 14.x.1966 (AD, K, PERTH); *M. Camb s.n.*, Porongorup plains, 20 miles E Karri Bank, 9.v.1968 (PERTH); *M.G. Corrick 7713,* Dillon Bay, 4.x.1981 (PERTH); *H. Doing s.n.*, NE Porongorup Range, 10.ix.1966 (CANB); *J. Drummond 5, 139*, Western Australia, -.-.1849 (BM, K, MEL, NSW, PERTH); *A.R. Fairall 417*, 236 mile peg on Albany Highway, 7.x.1962 (KPBG, PERTH); *J. Galbraith 944*, Albany, 7.x.1964 (MEL); *A.S. George 9659*, 11 mls S Arthur River, 10.x.1969 (PERTH); *M. Koch 2666,* Palgarup, N Manjimup, xi.1922 (K, MEL, NSW, PERTH); *F. Mueller MEL 92785*, Porongorup, s.d. (MEL); *K. Newbey 2761A*, 10 mls W Bremer Bay, 28.ix.1968 (PERTH); *M.E. Phillips 4012*, 14 miles from Darham to Collie, 1.x.1968 (CANB); *M.E. Phillips CBG 22750*, between Tambellup & Kandenup, 7.x.1962 (AD, CANB); *R.D. Royce 7667,* Cranbrook, 23.x.1962 (PERTH); *H.R. Toelken 7165,* 4 km N Manjimup, 22.x.1981 (AD, PERTH); *7113,* below Glen Eagles Picnic area, 27.x.1981 (AD, PERTH); *7120*, 7 km E Many Peaks, 28.x.1981 (AD, PERTH); *J.H. Willis MEL 92680*, Chester Pass, 4.ix.1949 (MEL); *P.G. Wilson 4217*, 25 km W Chester Pass, 28.ix.1966 (K).

Putative hybrids

12c(i) *K. micrantha* subsp. *oligandra* × *K. micromera*

K. recurva Schauer var. *melaleucoides* auct. non F. Muell. ex Benth.: Domin, Mém. Soc. Sci. Bohême (1921) 22, 2 : 87 (1923), partly, as for specimen cited.

Specimens are superficially similar to those of *K. micrantha* subsp. *oligandra* in their spreading habit, the bluntly acute incurved calyx lobes and fewer than 5 locules per ovary. However, the floral axis is densely covered with short hairs, the apices of lower bracts are usually rounded and without a raised central vein and, most significantly, the developing fruits show the characteristic bulging of the hypanthium immediately above the ovary, which are all characters of *K. micromera.*

Most of the specimens identified as this putative hybrid are from areas south-east of Ongerup where there are very few records of *K. micrantha* subsp. *oligandra*, so that all or some of the putative hybrid specimens may be variants of the latter. The taxon was treated here as a hybrid because of its straight or almost straight flowers and because it is usually being found in association with *K. micromera.*

Specimens examined

WESTERN AUSTRALIA; *B. Barnsley 510*, 38 km S Ravensthorpe, 21.viii.1979 (PERTH); *B. Cockman 9*, Moingup Spring, Stirling Range 7.ix.1987 (PERTH); *H. Demarz 508*, Bremer Bay road at turnoff to Gairdner River, 23.x.1968 (PERTH); *A.A. Dorrien-Smith s.n.*, Bridgetown to Kojonup and Slab Hut Gulley, -.-.1910 (K); *F. Stoward 40*, Cranbrook, 22.ix.1917 (PERTH); *H.R. Toelken 6480,* S Ongerup, 7.x.1979 (AD, PERTH); *7128*, N Bremer Bay, along Gorden Inlet Road, 29.x.1981 (AD, PERTH); *7130*, corner of Devils Creek and Gairdner Road, 29.x.1981 (AD, PERTH); *7135*, 4 km S Qualup HS, 29.x.1981 (AD, PERTH); *7139*, 3 km N Bremer Bay Road turnoff along Devils Creek South Road, 30.x.1981 (AD, PERTH).

12c(ii) *K. micrantha* subsp. *oligandra* × *K. recurva*

K. sprengelioides Turcz., Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Pétersbourg 10: 336 (1852); F. Muell., Fragm. 8: 183 (1874), pro species.

Type: Western Australia, *J. Drummond 5, 138* (*holo*.: KW — PERTH photo.; *iso*.: BM, MEL 92346, NSW, PERTH, W).

Plants appear as if they were particularly vigorous specimens of subsp. *oligandra* but the broader and rigid branches, the long hairs on the floral axis, the straight longer hypanthium of lower flowers as well as the broader petals (1.8–2.4 mm), indicate *K. recurva* as being the other putative parent. This hybrid is also usually easily recognised by its rather longer than broad calyx lobes, a character often found in *K. recurva*, but unlike the lobes in that species they have no recurved margins.

Specimens examined

WESTERN AUSTRALIA: *W.E. Blackall 4326*, Lake Clockerup, 20.xii.1939 (PERTH); *E.M. Canning CBG 37998*, 35 mls from Albany to Borden, 25.x.1968 (CANB); *CBG 51671*, 1.4 mls Jerramungup to Albany, 1.xi.1968 (CANB); *B.T. Goadby 92*, Hay River, -.x.1898 (NSW); *A. Meebold 10444*, Albany, -.viii.1933 (PERTH); *K. Newbey 1166*, 2 mls S Tambellup, 20.x.1963 (PERTH); *H.R. Toelken 6465*, 1 km S turnoff to Toompup, 7.x.1979 (AD, PERTH); *P.G. Wilson 4321*, 3 km W Bremer Bay township, 1.x.1966 (PERTH).

12d. subsp. **hirtiflora** Toelken, *subsp. nov.*

Subsp. *oligandrae* similis sed hypanthio axeque florali piloso et lobis calicis porcatis differt.

Type: Western Australia, NE Lake Muir, *H.R. Toelken 7899*, 25.ix.1988 (*holo*.: AD; *iso*.: K; PERTH).

Spindly shrublets 0.6–1 m tall, usually with erect stem, sparsely and untidily wiry branched, with fine appressed hairs when young. *Inflorescence* with 28–45 flowers, axis with dense spreading hairs obscuring stipuline trichomes; *lower bracts* obovate to -spathulate, bluntly acute to rounded, central vein more or less raised to the apex and with few long hairs towards the base. *Hypanthium* of lower flowers slightly curved, without raised veins, densely covered with forward-directed hairs, as long as or longer than bracts. *Calyx lobes* ovate, rounded to bluntly acute, papillose surface greyish-green except for broad membranous margins, distinctly ridged, erect or spreading after flowering. *Stamens* 14–17. *Ovary* with 2 locules each with 2, 3 (4) ovules. Flowers: September. Fig. 12K.

Distribution and ecology

Growing in temporary marshes and often partly submerged when flowering; known only from near Lake Muir. Map 5.

Conservation status

Probably in need of conservation but known only from two collections without many observations from the northern part of Lake Muir.

Diagnostic features

The subsp. *hirtiflora* is very similar to subsp. *oligantha*, but may be distinguished by its spindly erect habit, hairy hypanthium and floral axis, as well as its distinctly ridged calyx lobes.

Variation

This subspecies is only known from two collections which are remarkably uniform, so that a separate taxon is described here. The hairy hypanthium is so distinctive that the plants

were at first thought to be a hybrid between subsp. *oligandra* and *K. preissiana*, but the latter species has never been recorded that far west and hybrids with that species usually also have hairy leaves. Young leaves of subsp. *hirtiflora* are, however, glabrous except for some fine marginal cilia.

Etymology: The epithet '*hirtiflora*' (= with hairy flowers, Lat.) refers to the hairy hypanthium and calyx of flowers of this subspecies.

Specimens examined

WESTERN AUSTRALIA: *W.R. Barker 2346*, E of north end of Lake Muir, 13.ix.1977 (AD, PERTH); *H.R. Toelken 7899*, NE Lake Muir, 25.ix.1988 (AD, K, PERTH).

13. **K. micromera** Schauer in Lehm., Pl. Preiss. 2: 223 (1848); Benth., Fl. Austr. 3: 114 (1867), partly, excl. *J. Drummond 5, 135* and *G. Maxwell 211*; Domin, Mém. Soc. Sci. Bohême (1921) 22, 2: 87 (1923), partly, excl. *Pericalymma roseum*; Blackall & Grieve, West. Austr. Wildflow. edn 1, 1: 294 (1954); Beard, West Austr. Pl. edn 1, 77 (1965), partly; Blackall & Grieve, West. Austr. Wildflow. edn 2, 3A: 99 (1980); J. Green, Census Vasc. Pl. West. Austr. edn 2, 128 (1985).

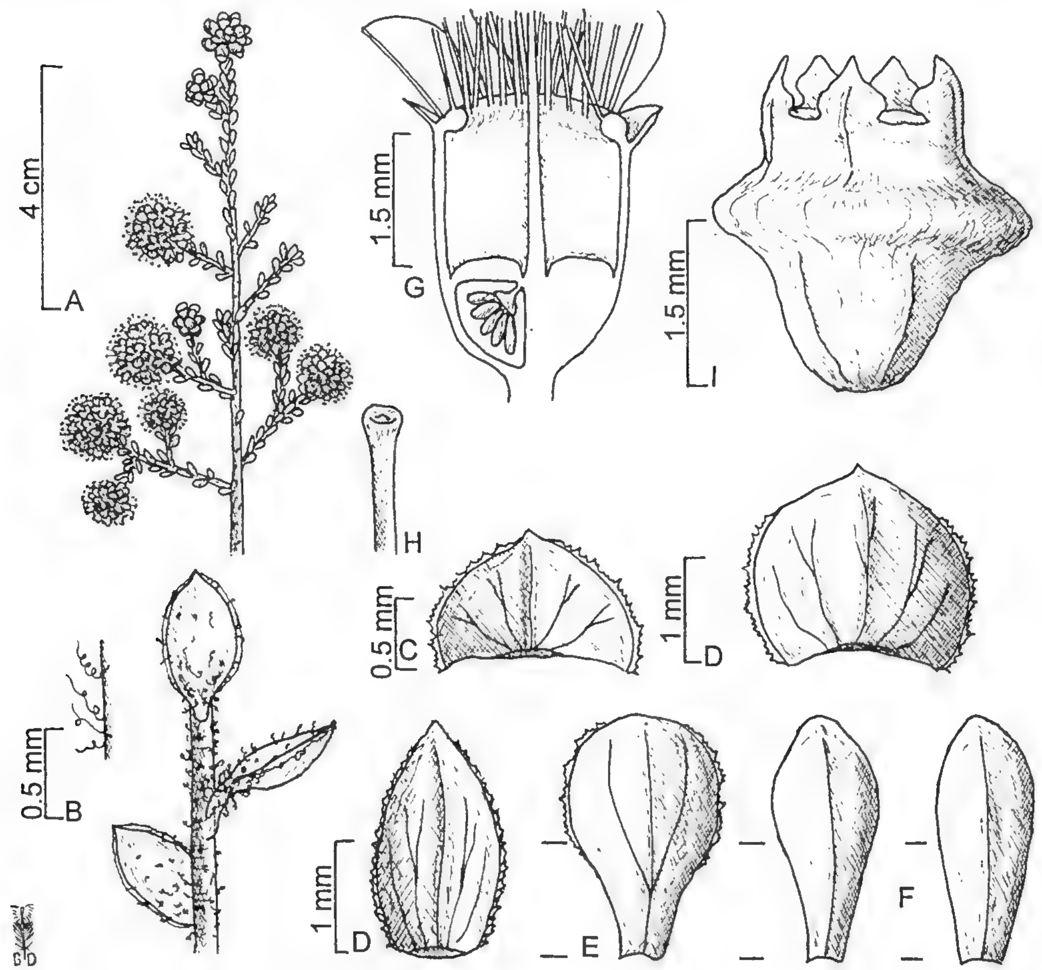


Fig. 13. *K. micromera* Schauer. A, flowering branch; B, branchlet showing coiled hairs; C, perule; D, lower bracts; E, upper bract; F, bracteole; G, half flower; H, stigma; I fruit. (A, G, H, *K. Newbey 478*; B, *A.S. George 6877*; C–F, I, *H.R. Toelken 7127*.)

Type: Western Australia, near ?Guildford, *J.A.L. Preiss 277* (*holo.*: MEL 92304).

Sparse shrublets (15–) 20–60 cm tall, with one to few wiry to somewhat woody stems, usually little branched; young branches with decurrent flanges scarcely raised, more or less densely covered with coiled, crisped or almost straight, short hairs soon becoming glabrous; early bark fibrous-mosaic, becoming more or less peeling and only slightly corky at least at first, shallowly fluted. *Leaves: petiole* 0.2–0.4 mm long, appressed; *lamina* oblanceolate to more or less elliptic, rarely broadly elliptic, (1–) 1.6–2.8 (–3.4) × 0.6–0.9 (–1.6) mm, bluntly acute to rounded or acute when immature, gradually or rarely abruptly constricted into petiole, above flat to slightly convex, usually distinctly convex below, with scattered coiled or rarely straight hairs often on both surfaces, soon becoming glabrous, with distinct horny margin often somewhat erose. *Inflorescence* a spherical botryum with (6–) 12–18 (–24) flowers, terminal on few long shoots, not clustered at the ends of branches, sometimes with terminal growth after flowering, others not continued on that branch often due to gall formation; *perules* depressed ovate to broadly ovate, acute to bluntly acute, rarely cuspidate or rounded, with 5–7 (–9) veins, glabrous or with short marginal cilia, or a tuft of hairs towards the apex; *bracts* broadly ovate at the base, becoming obovate-spathulate towards the apex of the inflorescence, 2–2.6 × 1.6–2.3 mm, rounded to bluntly acute, rarely truncate, with one to few veins, rarely with few hairs mainly along the midrib, cilia if present very short; *bracteoles* in pairs, oblanceolate to -spathulate, 1.5–2 × 0.6–1.3 mm, rounded and somewhat hooded, more or less hyaline, glabrous or with scattered hairs along the central vein, usually without marginal cilia. *Hypanthium* 2.6–3.2 mm long when flowering (free tube 1.4–2 mm), usually glabrous, with veins usually visible but rarely raised at base. *Calyx lobes* ovate, 0.8–1.1 mm long, rounded or rarely bluntly acute when margins incurved, glabrous. *Corolla lobes* obovate to orbicular, 1.4–1.9 (–2.2) mm long, pink or rarely magenta. *Stamens* 14–22 in more than one whorl; filaments 2.6–3.3 mm long; anthers with small subterminal gland. *Ovary* with 5 locules, surmounted by broad style base somewhat sunk into the upper surface; placenta a narrowly elliptic and scarcely fleshy disc with conical attachment connected to its centre, lobes connate mainly outside margins, each lobe with one row of ovules; 4–6 or up to 8 per locule in lower flowers, subequal, spreading to almost pendulous; style 3.2–4 mm long; stigma slightly broadened with central depression. *Fruit* an urceolate capsule with angular base often surmounted by obvious bulge, with erect calyx lobes. *Flowers*: October, November. Fig. 13.

Distribution and ecology

Plants have been recorded from clay, tillite or sandy substrate and are usually found in temporary moist depressions often in association with *K. recurva*; widespread but never common from near Stokes Inlet near Esperance to just east of Albany and in the north to near Narrogin and Newdegate. Map 4.

Conservation status

A rare species because although it has been recorded from such a wide area it is no where common. Conserved in Stirling Range National Park.

Diagnostic features

Although vegetatively very similar to *K. micrantha*, *K. micromera* is easily distinguished by its rounded short calyx lobes and smooth upper hypathium, which in *K. micrantha* is angular and usually has raised veins. The calyx lobes usually remain erect and green after flowering (rarely they become somewhat incurved possibly due to drying but even then do not cover the opening of the free hypanthium), while they are opaquely grey and incurved to close the opening of the hypanthium in its hybrid with *K. recurva*. These hybrid plants usually have much more robust main branches and 20–40 flowers per inflorescence.

Domin (1923) included *Pericalymma roseum* in the synonomy of *K. micromera*, but the type of that species is now included in 18(iii) *K. jucunda* × *K. preissiana*. The latter is distinguished from *K. micromera* by its hairy hypanthium and by the initially hairy calyx lobes, which tend to become glabrous.

Small plants of *K. praestans* might also be confused with *K. micromera* especially as they often also have short crisped hairs, but they produce rigid erect branches, leaves with straight margins, and have more than 30 stamens per flower.

Variation

Although *K. micromera* is widespread and populations often occur widely separated they show limited local variation. Plants from north of the Stirling Range and often those from south-east of Ongerup have coiled or crisped hairs on both sides of the leaves. These plants, and plants with glabrous leaves, or at the most with some long marginal cilia, often seem to occur in separate populations of a particular form, but they cannot be separated by any other character. Throughout most of the distribution range young branches are sparsely hairy and soon become glabrous. In the southern parts of the Stirling Range some plants are quite glabrous as even the floral axis may be without hairs except for the stipuline bristles (cf. *E. Wittwer 2082*). The hairy floral axis usually found in *K. micromera* should therefore not be used to distinguish it from *K. micrantha* subsp. *oligandra*.

As in the case of *K. micrantha*, young leaves are linear-oblanceolate with a long straight cuneate base which, in slow-growing plants, may become abruptly constricted into the petiole, while on actively growing branches the long gradual cuneate base is retained. Both forms can be seen on the same plant, or only one form is found on a plant, e.g. shade forms only have linear-oblanceolate leaves (*H.R. Toelken 7160*). In senescent plants the leaves are very small and somewhat convex below so that they become reminiscent of those of *K. jucunda*. Since these plants also usually produce very few flowers per inflorescence, it is tempting to refer them to hybrids but no plants with any other evidence of hybridisation between the two species could be found. The distinct horny margin and bulging fruit of *K. micromera* distinguish specimens where the individual habits are not apparent.

In mature vegetation one occasionally finds plants with long sinuous branches. These senescent plants tend to have very few branches and even fewer inflorescences so that they are rarely collected. They cannot be confused with plants of *K. micromera* × *K. recurva* with the rigid branches and many inflorescences (see below).

The horny margin usually found at least on relatively young leaves is often erose, which, when compared with very young leaves, shows that these unevennesses are persistent hair bases.

Beard (1967) in describing the height as '2–4 ft' seems to have followed Bentham (1867) in including some specimens of *K. jucunda*, as *K. micromera* has not been seen higher than 60 cm. Even an unusually robust specimen from near Newdegate (*J.M. Koch N115*) is described as 'woody shrub 40 cm'.

Typification

Since its discovery *K. micromera* has been confused with *K. micrantha*. Even Preiss, who had collected the types of both species, included them under the same collecting number, although it does not seem likely that *K. micromera* was ever found at a locality as far north as Guildford. Schauer (1844) described *K. micrantha* but must have realised later that the description did not fit the specimen in front of him at that time as he (Schauer 1848, p. 223) instructed the reader to delete *K. micrantha* from the list of species and to incorporate *K. micromera* in a different order before *K. recurva*, i.e. *K. micromera* was not regarded as being the same as *K. micrantha*. It would seem that he had examined and annotated at the

time the type of *K. micromera* in Sonder's herbarium – the only Preiss specimen of this species which is now in MEL — without having access to the specimens he previously described as *K. micrantha.* Inscriptions on *Kunzea* specimens relating to Schauer's descriptions were found with a few exceptions in the Vienna herbarium on specimens in Lehmann's herbarium now at LD (cf. K.L. Wilson 1983). The lack of an opportunity to make a direct comparison would also explain why he considered replacing *K. micrantha,* which he had seen only in bud, with *K. micromera.* This was confirmed by his writing on the later type: 'Kunzea micromera Schauer - fruher nach n. 277 in Knospen als K. micrantha beschr.'(earlier described as K. micrantha from No 277 in bud).

It is therefore argued here that *K. micromera* is not a later superfluous name for *K. micrantha.* Schauer (1848) attempted to clarify the circumscription of *K. micrantha* with the aid of another specimen of the type collection and in the process he inadvertently but by implication based the second name on a different type specimen (article 52.2d of the International Code of Botanical Nomenclature 1994). That is, the apparent contradictions of habit a foot high and not a compressed base of the hypanthium as opposed to a broader one, and significantly the 3-locular ovary compared with a 5-locular one respectively are no longer points of contention. In an attempt to clarify the circumscription of *K. micrantha* with the aid of mature flowering material Schauer described a new species based on a different type because he was unaware that the type collection (*Preiss 277*) consisted of two elements. This interpretation is accepted here and supports general usage of the two names since Bentham (1867).

The type of *K. micromera* consists of two small twigs with a few flowers showing the distinctive short rounded calyx lobes. Since only one specimen of *Preiss 277* of *K. micromera* was found and it contained Schauer's explanation for the problem encountered, it is assumed that this is the holotype, and that he examined only this one specimen (cf. lectotypification in the introduction).

Selection of specimens examined (48 seen)

WESTERN AUSTRALIA: *C.R.P. Andrews s.n.,* near Hopetoun, -.x.1903 (NSW, PERTH); *J.S. Beard 7460,* Chester Pass to Bluff Knoll, 25.ix.1975 (NSW); *P.E. Conrick 1664,* 5 km S Borden, 18.ix.1983 (AD, PERTH); *M. Cronin MEL 92786,* Bunbin near Lake Wagin, -.-.1890 (MEL); *A.A. Dorrien-Smith s.n.,* Bridgetown to Kojonup and Slab Hut Gulley, -.-.1910 (K); *H. Eichler 15944,* 1 km S Wansbrough, 31.viii.1959 (AD); *A.R. Fairall 481,* near Red Gum Springs, 9.x.1962 (KPBG, PERTH); *N. Hoyle 963,* 8 km W Kojonup, 21.x.1985 (PERTH); *E.N.S. Jackson 1295,* 8 km NW Young River crossing, 26.ix.1963 (AD, K); *J.M. Koch N115,* 20 km W Newdegate, 6.ii.1978 (PERTH); *F. Mueller MEL 92837,* Shannon, 12.xii.1877 (MEL); *K. Newbey 508,* 1 ml. W Needilup, 30.ix.1962 (PERTH); *523,* 11 mls E Jerramongup, 30.ix.1962 (PERTH); *A.F. Oldfield 351,* Kalgan River, s.d. (MEL 92543, K); *A.E. Orchard 1208,* 13 km N Stokes Inlet, 26.ix.1968 (AD, PERTH); *M.E. Phillips CBG 128387,* 13 mls S Narrogin, 1.x.1968 (CANB); *E. Pritzel 685,* District NW Plantagenet, 1.x.1901 (AD, G, K, NSW); *H.R. Toelken 6470,* Hill N Toompup HS, 7.x.1979 (AD, PERTH); *7129,* N Bremer Bay, 29.x.1981 (AD, PERTH); *7160,* 27 km W Raventhorpe on road to Jerramungup, 31.x.1981 (AD, PERTH); *W. Webb MEL 92713,* Bremer River, -.-.1884 (MEL); *E. Wittwer 2082,* Stirling Range road, 11.x.1977 (PERTH); *J.W. Wrigley CBG 30703,* between Red Gum Pass and Chester Pass, 10.x.1968 (AD, CANB).

Putative hybrids

13(i) *K. micrantha* subsp. *oligandra* × *K. micromera* see 12c(i) *K. micrantha* subsp. *oligandra.*

13(ii) ***K. micromera* × *K. montana***

The apparently decumbent habit, wiry branches which are villose with coiled hairs when young, shorter oblanceolate, usually stiff-erect ridged leaves with short petioles and coiled hairs which are also on the bracts, suggest *K. micromera* as one of the parents. The very broad spathulate bracts (4–4.6 mm broad), bracteoles with hairs along the central ridge, and altogether larger inflorescence and flowers (hypanthium 3.8–4.1 mm long) as well as 'flowers light pink' indicate *K. montana* as the second parent.

A specimen of *K. micromera* (*Wrigley CBG 30703*) was found by the same collector on the same day close to the locality where the above hybrid was found.

Specimen examined:

WESTERN AUSTRALIA: *J.W. Wrigley CBG 28334*, Mt Helen Powell near Redgum Springs, 10.x.1968 (CAMB; pollen sterility: 37%).

13(iii) *K. micromera* × *K. preissiana*

All parts of the plants including the hypanthium are more or less densely covered with hairs (but often become glabrous with age). The few flowers per inflorescence and the many short shoots on the plants are similar to *K. preissiana*, while the rounded lower bracts and the coiled hairs and the more or less decumbent habit are reminiscent of *K. micromera*. Both putative parents were found close by (e.g. *K. micromera*: *H.R.Toelken 7913*; *K. preissiana*: *H.R. Toelken 7915*).

Less hairy specimens (*B.G. Briggs NSW 124065, A.S. George 6877*), which agree except for rather narrow leaves with characteristics of *K. micromera*, are included here because of their scattered hairs on the hypanthium.

Other specimens, e.g. *H.R. Toelken 7127 & 7144*, which are also densely hairy on young branches and both sides of the leaves but not on the hypanthium, must be interpreted as variants of *K. micromera*.

Specimens examined

WESTERN AUSTRALIA: *A. Ashby 155*, Kulin, -.ix.1946 (PERTH); *B.G. Briggs NSW 124065*, 20 mls N Wagin, 7.x.1960 (CANB, NSW); *N.T. Burbidge 2401*, Lime Lake Siding, 10.ix.1947 (BRI, CANB); *J. Drummond 5, 135*, Swan River Colony, s.d. (K); *A.S. George 6877*, SE Ongerup, 26.x.1965 (PERTH); *K. Newbey 550*, 14 mls W Ongerup, 1.x.1962 (PERTH); *H.R. Toelken 6466*, 1 km S turnoff to Toompup,7.x.1979 (AD, PERTH); *6469*, hill above Toompup H.S., 7.x.1979 (AD, PERTH); *7165*, 1 km on road to Toompup, 1.xi.1981 (AD, PERTH); *7914*, 43 km N Boxwood Hill junction on road to Borden, 27.ix.1988 (AD, PERTH).

13(iv) *K. micromera* × *K. recurva*

The robust spreading habit, the larger leaves (up to 4 mm long), usually glabrous stems or in one case (*J.S. Beard 3650*) pubescent with straight hairs (except for floral axes which have usually long but crisped hairs as in *K. micromera*), and the shiny somewhat elongate calyx lobes are reminiscent of *K. recurva*. Although plants of this hybrid superficially resemble *K. recurva* they were never found to have the typical recurved calyx lobes of that species. They are also usually widely spaced and bluntly acute as in *K. micromera*, and unlike the similar *K. micrantha* subsp. *oligandra* they remain erect after flowering while the ovary has five locules. In several cases one or both putative parents have been recorded from the same locality as the hybrid.

Specimens examined

WESTERN AUSTRALIA: *J.S. Beard 3650*, 12 mls E Gairdner River, 18.x.1964 (KPBG, PERTH); *K. Newbey 503*, 10 mls E Ongerup, 30.ix.1962 (PERTH); *H.R. Toelken 6477*, Toompup, 7.x.1979 (AD, PERTH); *7116*, 2 km N Tunny, 27.x.1981 (AD, PERTH); *7166*, 1 km from turnoff to Toompup, 1.xi.1981 (AD, PERTH); *J.H. Willis MEL 92679*, 65 mls W Ravensthorpe, 3.ix.1947 (MEL).

C. **Kunzea** subsect. **Floridae** Toelken, *subsect. nov.*

A subsect. *Arborescentibus* fruticibus rare ad 2 m altis, (1–) 2–10 (–15) floribus in inflorescentia, floribus roseis vel purpureis;

a subsect. *Globosis* (1–) 2–10 (–15) floribus in inflorescentia, staminibus petala rare superantibus differt.

Type species: *K. affinis* S. Moore.

Shrubs (0.3–) 0.5–1.5 (–2.5) m, with usually few erect stems, each developing one to few main axes in the form of long shoots but being surrounded by more or less short shoots; bark on young branches (5–15 mm diam.) usually more or less fluted and fibrous, rarely slightly corky. *Leaves* usually linear, rarely oblanceolate, without horny margin. *Inflorescence* with (1–) 2–10 (–15) usually erect flowers, usually with vegetative growth after flowering from the terminal bud, rarely from axillary buds of the perules. *Petals* almost orbicular to obovate, usually rose-pink, often as long as or longer than stamens.

Distribution and ecology

Species of subsect. *Floridae* are, like those of subsect. *Globosae*, sometimes found in moist depressions which may even be prone to seasonal flooding, but more often they occur in dry scrub vegetation usually on sandy or gravelly soils mainly to the east, but some species extend to the south-east, of the Darling Range. Their distribution overlaps in the western part with some of the species of subsect. *Globosae* up to a line more or less between Bremer Bay and Jerramungup, but some species of the *Floridae* extend eastwards to east of Israel Bay, though they are then widely scattered. Species of subsect. *Floridae* were not found in the immediate vicinity of those of subsect. *Arborescentes*, which could be attributed to their different habitat preferances.

Notes

The epithet *Floridae* may seem a misnomer for a group of plants in which an important distinguishing feature is the low number of flowers in the inflorescence. The name was chosen, however, to draw attention to the tendency in this group towards an overall increase in the total number of flowers on each plant by the production of innumerable inflorescences terminal to most branches. This is particularly found in, for example, *K. affinis* and *K. jucunda* (cf. fig 14). These species also show well the development of lateral shoots, which by repeatedly branching form the intricate branching system around the main branches characteristic of this subsection.

Since the actual number of flowers per inflorescence may be affected in species of subsections *Floridae* and *Globosae* by conditions, such as, age or season, overlap in flower number has been observed between these subsections. The common development of subterminal short shoots with inflorescences as well as the intricate branching system in subsect. *Floridae* are therefore additional discriminating characters. All branches of species in subsections *Arborescentes* and *Globosae* are long shoots with at least 10 internodes, except for an occasional subterminal inflorescence on a shot branch. Long shoots of species of subsect. *Floridae* elongate considerably each year and usually terminate in an inflorescence or sometimes, as in species of the other subsections, even remain vegetative under particularly favourable conditions. The long shoots in all three subsections branch normally but in species of the subsection *Floridae* they usually also produce subterminal short shoots with inflorescences. Although some of these lateral long and short shoots in the *Floridae* may subsequently again become activated as part of the main branch system, most remain short and branch regularly to form an intricate branch system around the main branches. The subterminal short shoots have fewer than six internodes but this depends on the vigour of the whole plant, being determined by either the season or the age of the plant. Equally the long shoots may become reduced so that the two types of shoots can often not be clearly distinguished.

In some species (e.g. *K. similis* and *K. preissiana*) the lower intricate branches remain vegetative, while in others (e.g. *K. affinis* and *K. jucunda*) most shoots of the intricate branching system develop inflorescences as do most side branches formed on them. Later the number of flowers on individual inflorescences bercome fewer and ultimately not all branches bear terminal inflorescences at all. Herbarium specimens representing only the upper parts of plants do not permit long term morphological analyses. To heighten the effect of this intricate branching habit many of the shoots branch either immediately after

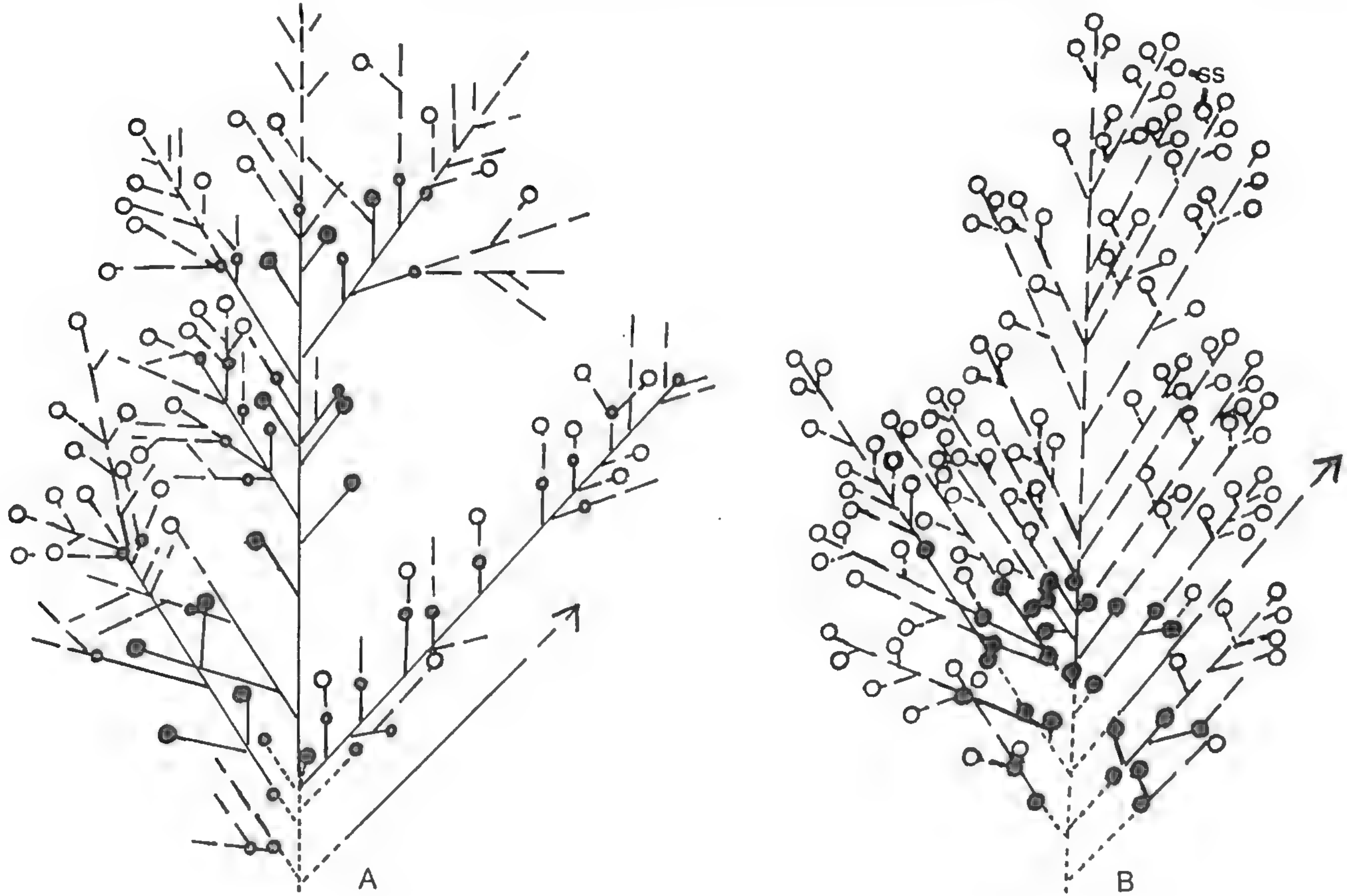


Fig. 14. Diagram of three years' growth. A, *K. **recurva*** Schauer (subsect. *Globosae*) showing few inflorescences on irregular branching of mainly long shoots rarely with subterminal short shoots (*H. Eichler 16111*). B, *K. **jucunda*** Diels (subsect. *Floridae*) showing development of numerous inflorescences terminal on long shoots and commonly with subterminal short shoots (ss), and repeated branching of lateral branches to form an intricate branch system around the main branch (*F. Lullfitz 3369*). First year--; 2nd year –; 3rd year ···; present O and past inflorescences ●; past vegetative buds •.

the terminal vegetative bud of the inflorescence starts growing, or several axillary buds below the inflorescence grow into branches particularly, but not necessarily, if gall development has severed the terminal bud. The development of galls in perennating terminal buds is common in most species of subsect. *Floridae* but has also been recorded in some species of subsect. *Globosae.*

In subsect. *Floridae* inflorescence production is not only generally restricted to short shoots but these branches also continue to produce terminal inflorescence for several years. Species of subsect. *Globosae* and *Arborescentes* rarely produce inflorescences on short shoots and if so these do not continue to produce inflorescences (cf. fig. 14A).

It is noteworthy that a similar habit is found in *K. parvifolia*, a species widespread in eastern Australia and otherwise bearing little resemblance to the Western Australian species except in often occuring in drier areas or on very shallow soil on rocks.

Another characteristic of subsect. *Floridae* is the relatively large corolla so that the stamens are not or are only marginally longer than the petals. Although no field observations have been made there are indications that the flowers possess a different pollination syndrome from the other two subsections. This is best shown in the low number of hybrids produced with species of subsect. *Globosae* although these species often grow next to one another. Hybridisation is, however, possible as two specimens were investigated which are considered to be a hybrid of *K. micromera* and *K. preissiana*. The second indication of a different pollination system in subsect. *Floridae* stems from several records of scented flowers in *K. affinis* which, however, occupies an extreme position in this subsection. Personal observations have confirmed that scented flowers also occur on some plants of *K. preissiana* and *K. jucunda*. The flower biology of the genus needs to be studied as it does not follow a broad spectrum pollinating agent syndrome as reported for much of the Myrtaceae in Australia.

The three species, *K. similis, K. acuminata* and *K. pauciflora*, which were placed together at the beginning of the subsection have little in common other than the pointed calyx lobes, which immediately distinguish them from the remaining species with rounded ones. These three have been recorded from very restricted distributions widely separated from one another. They should probably be seen as relics each with a very restricted distribution and are now not closely related to one another or the main group of species although they obviously belong in this subsection. These three species could be considered early evolutionary divergents as they often have larger flower heads which are often not borne on short shoots.

Key to species and hybrids of subsect. *Floridae*

N.B. The size and shape as well as tomentum of the first three leaves produced on each branch are often abnormal and should not be used.

1. Ovary with 2 locules, each with 1 or 2 ovules; leaves club-shaped and with straight appressed hairs .... 21. *K. eriocalyx*

1: Ovary with 5 rarely 3 locules each with 6 or more ovules; leaf lamina linear, elliptic or if oblanceolate then ± flat, or if somewhat club-shaped then with coiled hairs:

  2. Young leaves hairy on both surfaces; calyx lobes densely hairy at least when young:

    3. Hairs on leaves and branches coiled; near Ravensthorpe:

      4. Leaves club-shaped, (2.8–) 3.5–6.4 (–7.3) mm long .... 20. *K. cincinnata*

      4: Leaves dorsiventrally compressed, linear-elliptic, 2.1-3.2 mm long .... 20(i). *K. cincinnata* × *K. juncunda*

    3: Hairs on leaves and branches straight or irregularly twisted; widespread:

      5. Ovary 3-locular; calyx lobes pointed .... 14. *K. similis*

      5: Ovary 5-locular; calyx lobes bluntly acute to rounded:

        6. Hairs on upper surface of leaves shorter and fewer .... 19(ii). *K. affinis* × *K. preissiana*

6: Hairs on both leaf surfaces equally long and dense:

7. Bracts acute to acuminate, densely covered with spreading hairs; hairs on leaves and inflorescence 0.4–1.2 mm long .... 17. *K. preissiana*

7: Bracts rounded rarely with bluntly acute or mucronate apex, with hairs dense to becoming patchy and ± appressed; hairs on leaves and inflorescence 0.15–0.25 mm long .... 13(iii). *K. micromera* × *K. preissiana*

2: Young leaves glabrous on upper surface; calyx lobes glabrescent to glabrous:

8. Calyx lobes acute:

9. Hypanthium and bracts glabrous .... 16. *K. pauciflora*

9: Hypanthium and calyx hairy .... 15. *K. acuminata*

8: Calyx lobes bluntly acute to rounded unless folded:

10. Hypanthium and calyx glabrous:

11. Young branches with long appressed hairs:

12. Leaf lamina linear; bracts usually beaked .... 19. *K. affinis*

12: Leaf lamina elliptic; bracts rounded rarely mucronate .... 19(i). *K. affinis* × *K. jucunda*

11: Young branches glabrous or with a few spreading hairs .... 18. *K. jucunda*

10: Hypanthium and/or calyx glabrescent (tomentum of calyx often varying from lobe to lobe):

13. Bracts acute to acuminate; leaf lamina (3–) 4–6 (–8) times longer than broad .... 19(ii). *K. affinis* × *K. preissiana*

13: Bracts rounded, rarely mucronate; leaf lamina (1.5–) 2–2.5 (–3) times longer than broad .... 18(iii). *K. jucunda* × *K. preissiana*

14. **K. similis** Toelken, *sp. nov.*

K. capitatae persimilis sed foliis uninervibus et ovariis ovulis paucis biserialibus differt.

K. preissianae similis sed saepe inflorescentiis multifloribus quibus terminalibus sunt, calicis lobis longis acutissimis, ovariis trilocularibus differt.

Type: Western Australia, East Mt Barren, 8.x.1979, *H.R. Toelken 6500* (*holo.*: AD, *iso.*: G, K, MO, NSW, PERTH, S).

Shrubs (0.3–) 0.5–1 (–1.5) m tall, with several erect main stems, moderately to little branched, with basal lateral branches spreading and usually without flowers; young branches with decurrent flanges scarcely raised, densely covered with long and short spreading hairs becoming very long and silky (up to 1.3 mm) below inflorescences and at the beginning and end of growth flushes; early bark fibrous-mosaic, unequally splitting, becoming fibrous-peeling and scarcely corky. *Leaves*: *petiole* 1.3–1.5 mm long, appressed; *lamina* oblanceolate to linear-oblanceolate, (3.2–) 4–5 (–5.4) × 1.4–2.8 (–4) mm, bluntly acute often becoming rounded, gradually constricted into petiole, concave above particularly below the apex becoming almost flat, slightly convex below and with pronounced but rounded subterminal point, with scattered fine hairs or glabrous above, silky hairy below becoming glabrous. *Inflorescence* a spherical or rarely hemispherical botryum with (3–) 4–10 (–12) mature flowers (often up to 4 aborted flowers at base), terminal on long and short shoots, never clustered at the end of branches, with terminal vegetative growth after flowering; *perules* 5, 6 or if more then bracts with a rudimentary flower, ovate to broadly ovate, acuminate with long or short beak, with numerous but indistinct veins, covered with long silky hairs outside; *bracts* ovate to lanceolate at the apex of the inflorescence, 3.8–4.3 × 1.6–2.5 mm, acuminate to almost cuspidate with several often indistinct veins, densely covered with long silky hairs outside; *bracteoles* in pairs, linear to linear-oblanceolate, often falcate, 3.2–3.5 × 0.4–0.6 mm, acute to rounded, with central vein, densely covered with long silky hairs. *Hypanthium* 4.5-6 mm long when flowering (free tube ca 3–3.5 mm), densely covered with long silky hairs. *Calyx lobes* triangular, 1–1.3 mm long, acute, ridged at least towards the apex, densely covered with silky hairs. *Corolla lobes* obovate-spathulate, 3–3.5 mm long, clawed, pink. *Stamens* 32–44 in more than one whorl; filaments 5.6–6.4 mm long; anthers with small almost terminal

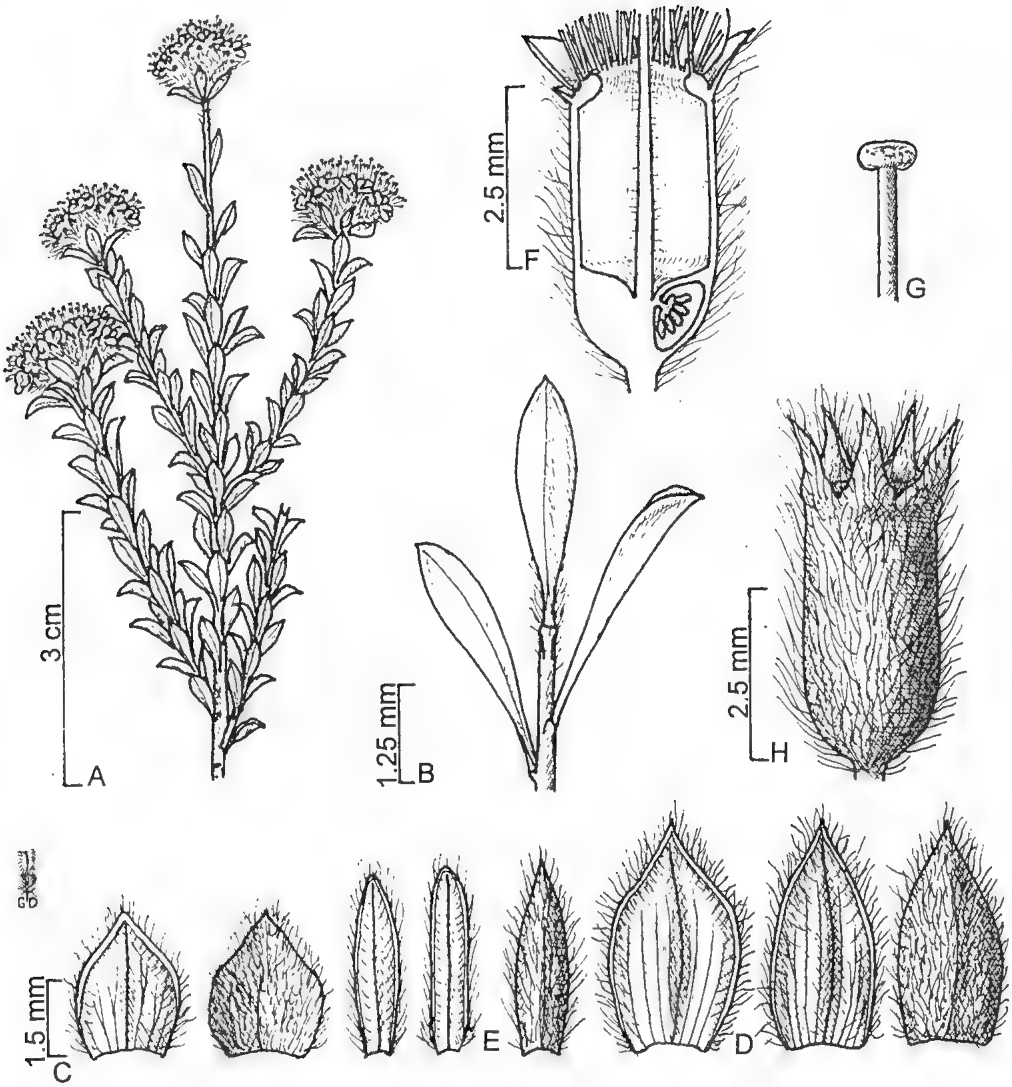


Fig. 15. ***K. similis*** Toelken. A, flowering branch; B, branchlet; C, perule; D, bracts; E, bracteoles; F, half flower; G, stigma; H, fruit. (A–H, *H.R. Toelken 6500.*)

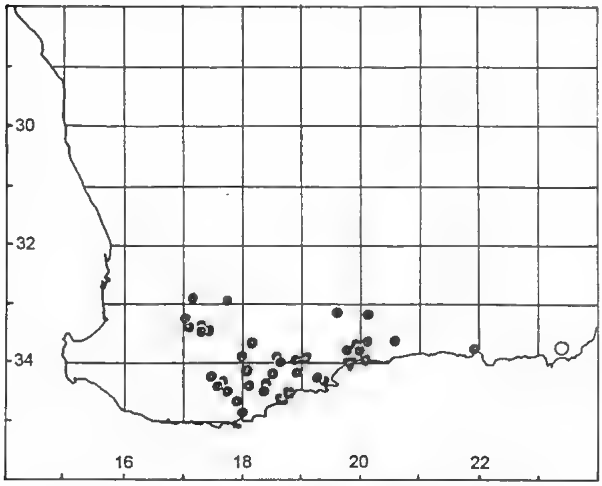
gland. *Ovary* with 3 locules, with style slightly sunk into the upper surface; placenta an elliptic disc with short thin attachment from the middle, with lobes connate mainly along the margins, each lobe with 1 or 2 rows of ovules; ovules 8 (–10) per locule, spreading or 2 lowest ones pendulous and slightly longer; style 4–4.7 mm long, slightly broadened towards base; stigma enlarged disc with central depression. *Fruit* an elongate urceolate capsule more or less constricted below the erect calyx calyx lobes. *Flowers*: October. Fig. 15.

Distribution and ecology

Known only from one very localised population growing on sandy soil in Fitzgerald River National Park near Hopetoun. Map 6.

Conservation status

The very restricted known distribution makes *K. similis* a vulnerable species, which is, however, conserved in the Fitzgerald River National Park.



Map 6. *K. similis* ▼; *K. acuminata* O; *K. pauciflora* ◘; *K. preissiana* ◉.

Diagnostic features

K. similis is superficially very similar to *K. capitata* (sect. *Kunzea*) because of the stiffly erect wiry branches producing lateral branches mainly at the beginning of each new growth flush, and because of the long silky hairs on and below the inflorescences. It is, however, easily distinguished, and the single-veined leaves and small number of ovules show that it should be placed in the sect. *Zeanuk*, and more specifically in subsect. *Floridae* because of its close similarity to *K. preissiana* in spite of its sometimes producing more than ten flowers (including sterile ones) per inflorescence, mainly terminal growth above the botryum and long stamens.

Specimens examined

WESTERN AUSTRALIA: *A.R. Fairall 2391*, near Hopetoun 11.x.1967 (KPBG, PERTH); *H.R. Toelken 6500*, near Hopetoun, 8.x.1979 (AD, G, K, MO, NSW, PERTH, S); *7152*, near Hopetoun, 31.x.1981 (AD, PERTH).

15. **K. acuminata** Toelken, *sp. nov.*

K. simili similis sed foliis linearo-oblanceolatis, perulis et bractis acuminatis, stylis pubescentibus ad basim differt.

K. affini apperenter similis sed hypanthio caliceque sericeo, bracteis acuminatis, longioribus hypanthiis, ovariis trilocularibus differt.

Type: Western Australia, 45 km W of Israelite Bay, 21.ix.76, *R.J. Hnatiuk 761251* (*holo.*: PERTH; iso.: PERTH).

Shrubs up to 2 m tall, with few spindly upper branches; young branches with decurrent flanges slightly raised, sericeous with mainly long hairs but also some shorter ones, becoming tortuous before wearing off; early bark fibrous to fibrous-mosaic, becoming slightly corky but remaining fibrous. *Leaves: petiole* 1.1–1.5 mm long, more or less appressed to branch; *lamina* linear-oblanceolate, rarely linear-elliptic, (4.3–) 6.3–7.2 (–7.6) × (0.8–) 0.9–1.1 (–1.3) mm, usually bluntly acute, with slightly recurved apex, gradually tapering into the petiole, concave above, more or less convex below, with long appressed hairs along margins. *Inflorescence* a spherical botryum with 8–15 flowers terminal on mainly long shoots, rarely clustered at the end of branches, with terminal vegetative growth as well as lateral from below the inflorescences after flowering; *perules* usually more than 5, obovate-acuminate with many veins, sericeous; *bracts* obovate, acuminate or rostrate to oblanceolate, with a beak about as long as broad base of bract, (4.8–) 5.6–7 (–7.5) × 1.8–2.9 mm, with many veins from the base, sericeous; *bracteoles* in pairs, linear-subulate, 4.40–5.20 × 0.3–0.5 mm, with one central vein, sericeous. *Hypanthium* ca 4.5 long when in bud (free tube ca 2.5 mm long) scarcely angular, sericeous. *Calyx lobes* ovate, 1.2–1.6 mm

long, acute to acuminate, slightly ridged towards the apex, sericeous. *Corolla lobes* obovate, ca 1.6 mm (immature), clawed, pink. *Stamens* 50–55 in more than one whorl; filaments ca 4.5 mm long (immature); anthers with small subterminal gland. *Ovary* with 3 locules, with style slightly sunk into the upper surface; placenta an elliptic disc with short attachment from near the middle, lobes connate mainly along the margins, each with one row of ovules; ovules 8–10 per locule, spreading or 2–4 lowest ones pendulous and slightly longer; style broadened towards the base and with scattered hairs; stigma immature. *Fruit* not seen. *Flowers*: September. Fig. 16.

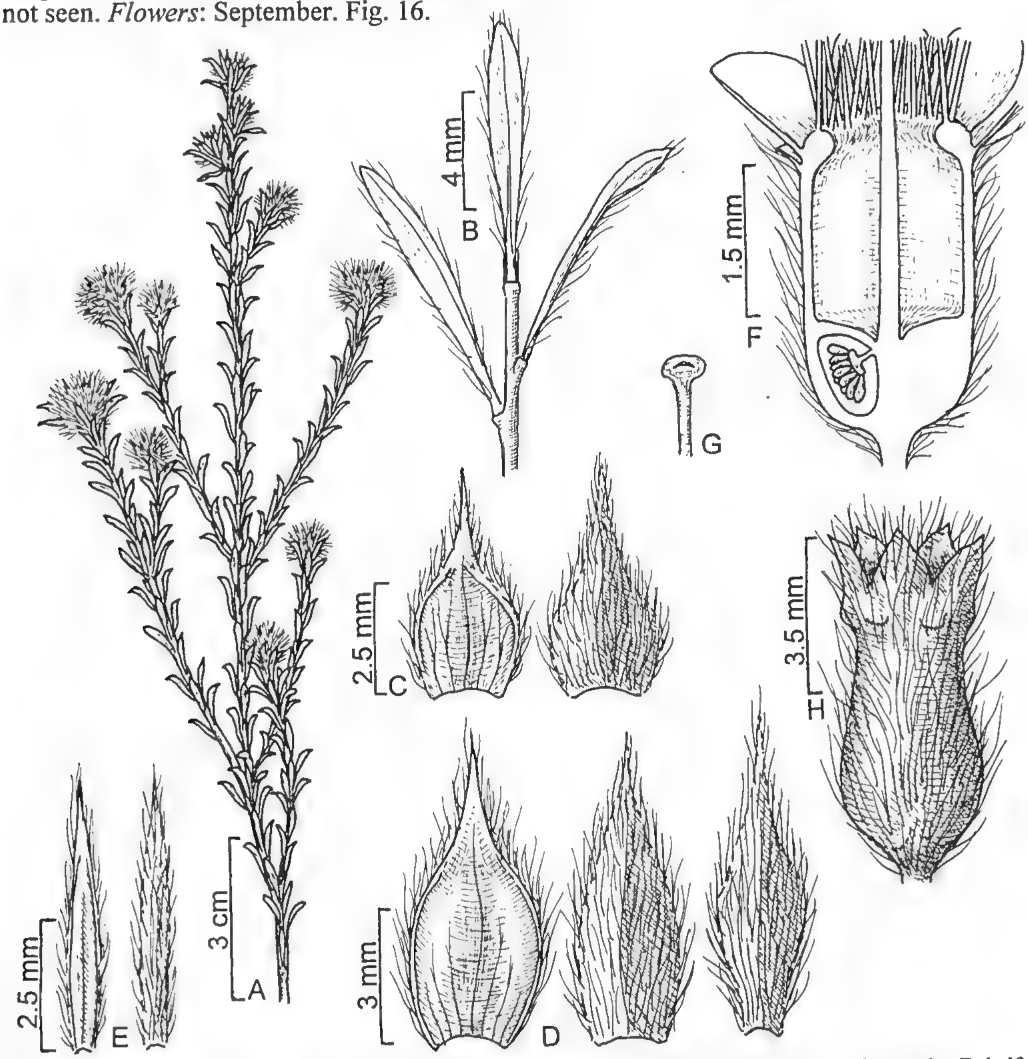


Fig. 16. *K. acuminata* Toelken. A, flowering branch; B, branchlet; C, perule; D, bracts; E, bracteole; F, half flower; G, stigma; H, fruit. (A–H, *R.J. Hnatuik 761251.*)

Distribution and ecology

Known only from one collection where it was growing in sandy soil over granite in 'open heath' vegetation 45 km west of Israelite Bay. Map 6.

Conservation status

The type collection does not give any indication of how common the plant is. Since this record is from much further east than of any other species of subsect. *Floridae,* it is assumed that *K. acuminata* is a vulnerable relict with a restricted distribution.

Diagnostic features

K. acuminata is similar to *K. similis* in its sparse though more woody habit, inflorescences with more flowers than usual in the subsection, sericeous flowers and bracts and trilocular ovary. The acuminate perules and bracts with a beak about as long as the base are characteristic and hence the choice of epithet. They are longer than the flower buds in contrast to those of *K. affinis* which are also sometimes acuminate but always distinctly shorter than the hypanthium.

Specimen examined

WESTERN AUSTRALIA: *R.J. Hnatiuk 761251,* 45 km W Israelite Bay, 21.ix.76 (PERTH).

16. **K. pauciflora** Schauer in Lehm., Pl. Preiss. 1: 124 (1844); Benth., Fl. Aust. 3: 114 (1867); F. Muell., Syst. Census Austr. Pl. edn 1: 5 (1882); edn 2: 93 (1884); Blackall & Grieve, West. Austr. Wildflow. edn 1: 294 (1954); Beard, West Austr. Pl. edn 1: 77 (1965); Blackall & Grieve, West. Austr. Wildflow. edn 2, 3A: 100 (1980); J. Green, Census Vasc. Pl. West. Austr. edn 2: 128 (1985).

Type: Western Australia, Konkoberup, Cape Riche, *J.A.L. Preiss 259,* (*lecto.* — selected here: LD; *syn*: G, MEL (2×), W).

Pericalymma teretifolium Turcz., Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Pétersbourg 10: 334 (1852); F. Muell., Fragm. 8: 183 (1874).

Type: Western Australia, *J. Drummond 5, 134* (*holo.*: KW — PERTH photo; *iso.*: BM, K, MEL, NSW, PERTH, W).

Shrubs (0.35–) 0.5–1.2 (–1.5) m tall, with few to many stems from the base, each becoming densely branched towards the apex, flowers usually only at the top; young branches with decurrent flanges scarcely raised, glabrous; early bark fibrous-mosaic, unequally splitting, becoming fibrous-peeling. *Leaves*: *petiole* 0.4–0.9 (–1.2) mm long, appressed; *lamina* linear, rarely linear-elliptic, (3.2–) 3.4–6.5 (–8.8) × 0.4–0.8 (–1.0) mm, bluntly acute to rounded, rarely acute below inflorescence, scarcely constricted into petiole, flat or convex above, strongly convex below, sometimes with few marginal hairs when very young. *Inflorescence* an often hemispherical botryum with 1–3 (–5) slightly pedicellate flowers, terminal on mainly long shoots but sometimes clustered at the end of branches, with usually several vegetative branches from below the inflorescence or rarely with terminal growth after flowering; *perules* (0) 1 or 2, often caducous, lanceolate to broadly ovate, rostrate with beak often longer than broad base of perule, with numerous but usually indistinct veins particularly on the hyaline basal margins, glabrous except for some marginal cilia; *bracts* ovate to ovate-oblong, (2.3–) 2.6–3.5 (–4.6) × 1.2–1.6 mm, acuminate to rostrate, with several often indistinct veins on broad hyaline margins, glabrous except for marginal cilia at least below the beak; *bracteoles* in pairs, lanceolate to oblong-lanceolate or often obviously constricted towards the base, often somewhat falcate, 2.7–3.2 (–4) × 0.8–1.4 (–1.6) mm, acuminate, with central vein between hyaline lobes, glabrous or with few scattered cilia. *Hypanthium* (3.2–) 3.4–4.4 mm long when flowering (free tube 2–2.3 mm), glabrous. *Calyx lobes* triangular or linear-triangular because margins are incurved, 2–2.6 mm long, acute to pointed, scarcely ridged towards the apex, glabrous. *Corolla lobes* orbicular or depressed ovate, 3.6–4 mm long, shortly clawed, pink. *Stamens* (33–) 39–46 in more than one whorl; filaments 3.3–4.1 mm long; anther with small, almost terminal gland. *Ovary* with (4) 5 locules, style slightly sunk into the upper surface; placenta an elliptic disc

with short attachment from just above the middle, lobes connate mainly along the margins, each lobe with 1 or 2 rows of ovules; ovules (8–) 10–13 per locule, spreading or lowest ones pendulous and scarcely longer; style slightly broadened towards the base, 6–6.4 mm long; stigma enlarged disc. *Fruit* urceolate with erect calyx lobes. *Flowers*: October. Fig. 17.

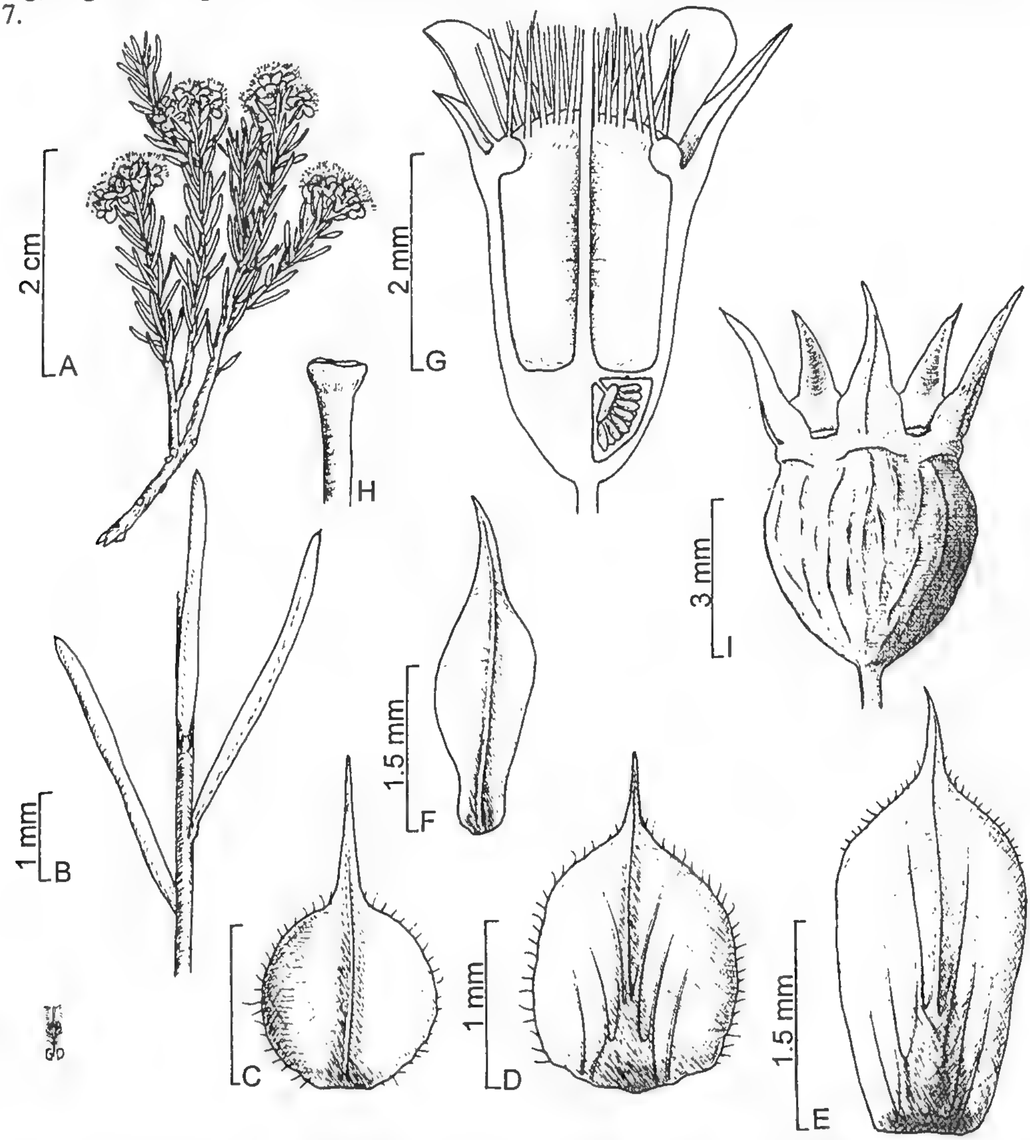


Fig. 17. *K. pauciflora* Schauer. A, flowering branch; B, branchlet; C, perule; D, lower bract; upper bract; F, bracteole; G, half flower; H, stigma; I, fruit. (A, *A.S. George 6902*; B–I, *J.W. Wrigley CBG 36319*.)

Distribution and ecology

Known only from the vicinity of Cape Riche where it grows in rocky to gravelly soil. Map 6.

Conservation status: 2V (Briggs & Leigh 1988).

Diagnostic features

The robust habit and long hypanthium (3–4 mm) as well as the long, pointed calyx lobes (2–2.6 mm) distinguish *K. pauciflora* from other species in this subsection. It agrees with most characteristics of this subsection although it has an unusually robust habit and larger flowers more typical of subsect. *Globosae.* The relatively large flowers are, however, also found in the similarly coastal species *K. similis* and *K. acuminata.*

Typification

The specimen of *Preiss 259* at LD was selected as the lectotype because it was the only specimen annotated by Schauer.

Specimens examined

WESTERN AUSTRALIA: *J. Drummond 3, 39*, Swan River Colony (K); *4?, 56*, Konkoberup Hills towards Cape Riche (K); *5, 134*, Konkoberup (BM, K, MEL, NSW, PERTH, W); *Miss Franklyn 5*, Mungden? -.12.1884 (MEL); *C.A. Gardner 2165*, Cape Riche, 9.x.1928 (PERTH); *6525*, Konkoberup Hills, 11.x.1942 (PERTH); *C.A. Gardner & W.E. Blackall s.n.*, Cape Riche, -.x.1928 (PERTH); *A.S. George 6902*, Mt Melville, 26.x.1965 (PERTH); *s.n.*, Cape Riche, (K); *K. Newbey 2934*, Mt Melville, -.x.1969 (PERTH); *A.F. Oldfield s.n.*, (K); *J.A.L. Preiss 259*, Konkoberup, -.xi.1840 (G, LD, MEL, W); *H.R. Toelken 7123*, Cape Riche, 28.x.1981 (AD, PERTH); *J.W. Wrigley CBG 36319*, Cape Riche, 25.x.1968 (CANB).

17. **K. preissiana** Schauer in Lehm., Pl. Preiss. 1: 125 (1844); Benth., Syst. Fl. Austr. Pl. 3: 113 (1867); F. Muell., Syst. Census Austr. Pl. edn 1: 54 (1882); edn 2: 93 (1884); Blackall & Grieve, West. Austr. Wildflow. edn 1, 2: 294 (1954); Beard, West Austr. Pl. edn 1: 77 (1965); Blackall & Grieve, West. Austr. Wildflow. edn 2, 3A: 100 (1980); J. Green, Census Vasc. Pl. West. Austr. edn 2: 128 (1985).

Type: Western Australia, without precise loc., *Preiss 276* (*lecto.* — selected here: LD).

K. villiceps Schauer in Lehm., Pl. Preiss. 1: 125 (1844); Domin, Mém. Soc. Sci. Bohême (1921) 22, 2: 87 (1923).

Type: Western Australia, arid plains near Gordon River, *Preiss 275* (*lecto.* — selected here: LD).

K. preissiana Schauer var. *villiceps* (Schauer)Benth., Fl. Austr. 3: 114 (1867).

K. villiceps Schauer var. *glabrior* Domin, Mém. Soc. Sci. Bohême (1921) 22, 2: 87 (1923).

Type: Western Australia, Slab Hut Creek to Cranbrook, *A.A. Dorrien-Smith s.n.* (*holo.*: K).

K. preissiana Schauer var. *glabra* Blackall & Grieve, West. Austr. Wildflow. edn 1: 2: 294 (1954), nom. inval.

Shrubs 0.5–1.2 (–1.8) m tall, with few erect stems each with spreading branches from the base; young branches with flanges indistinct and often only along part of the internodes, usually densely covered with fine (long and short) spreading hairs; early bark irregularly fissured, fibrous-peeling, grey. *Leaves*: *petiole* 0.2–0.7 mm long, more or less appressed; *lamina* oblanceolate to linear-oblanceolate, rarely elliptic or elliptic-lanceolate, (2.2–) 3–6 (–7.6) × (0.2–) 0.4–1.2 mm, acute, often becoming bluntly acute to rounded, gradually constricted into petiole, more or less concave, often becoming flat above, slightly convex to ridged below, appressed on long shoots, spreading on short ones, more or less densely covered with long fine hairs on both surfaces, spreading at about right angles when old. *Inflorescence* a botryum with (2–) 3–7 (–12) flowers, terminal on long and short shoots, with mainly terminal growth after flowering, sometimes especially on short shoots immediately branching; *perules* usually few (ca 3), often caducous, ovate, cuspidate, rarely almost truncate, with one central vein, densely covered with short cilia and spreading hairs often longer towards the apex; *bracts* broadly obovate-spathulate, 2.2–3.8 × 1.8–2.4 mm, cuspidate to rarely truncate, mucronate, usually with 3 veins from the base, more or less densely covered with spreading hairs that often wear off towards the apex; *bracteoles* in pairs, linear-oblanceolate to linear, 2.8–4.1 × 0.4–1 mm, acute, with one central vein, densely covered with long spreading hairs. *Hypanthium* 2.8--3.7 mm long when flowering

(free tube 1–1.5 mm long), densely covered with spreading forward-directed hairs. *Calyx lobes* ovate to lanceolate, 0.9–1.3 mm long, bluntly acute to rarely rounded, margins slightly incurved, densely covered with long, forward-directed hairs rarely becoming glabrous towards the apex. *Corolla lobes* obovate to orbicular-spathulate, 2.5–2.9 (–3.3) mm long, with short claw, pink to mauve. *Stamens* 18–32 in more than one whorl, as long as or scarcely longer than corolla lobes; filaments 2.2–2.7 (–3) mm long; anthers with large subterminal gland. *Ovary* with 5 locules, surmounted by a broad style base partly sunk into the upper surface; placenta a narrowly elliptic disc, little fleshy, with ascending attachment connected to middle, lobes only connate on the outside margins, each lobe with one row of ovules; ovules 10–12 (–14) per locule, spreading or lower ones pendulous; style 2.7–4.1 mm long, broadened towards the base; stigma scarcely capitate and little depressed at apex. *Fruit* an urn-shaped capsule usually with 5 vertical ridges partly hidden in the tomentum, with calyx lobes spreading at about right angles. *Flowers*: (August) September, October. Fig. 18.

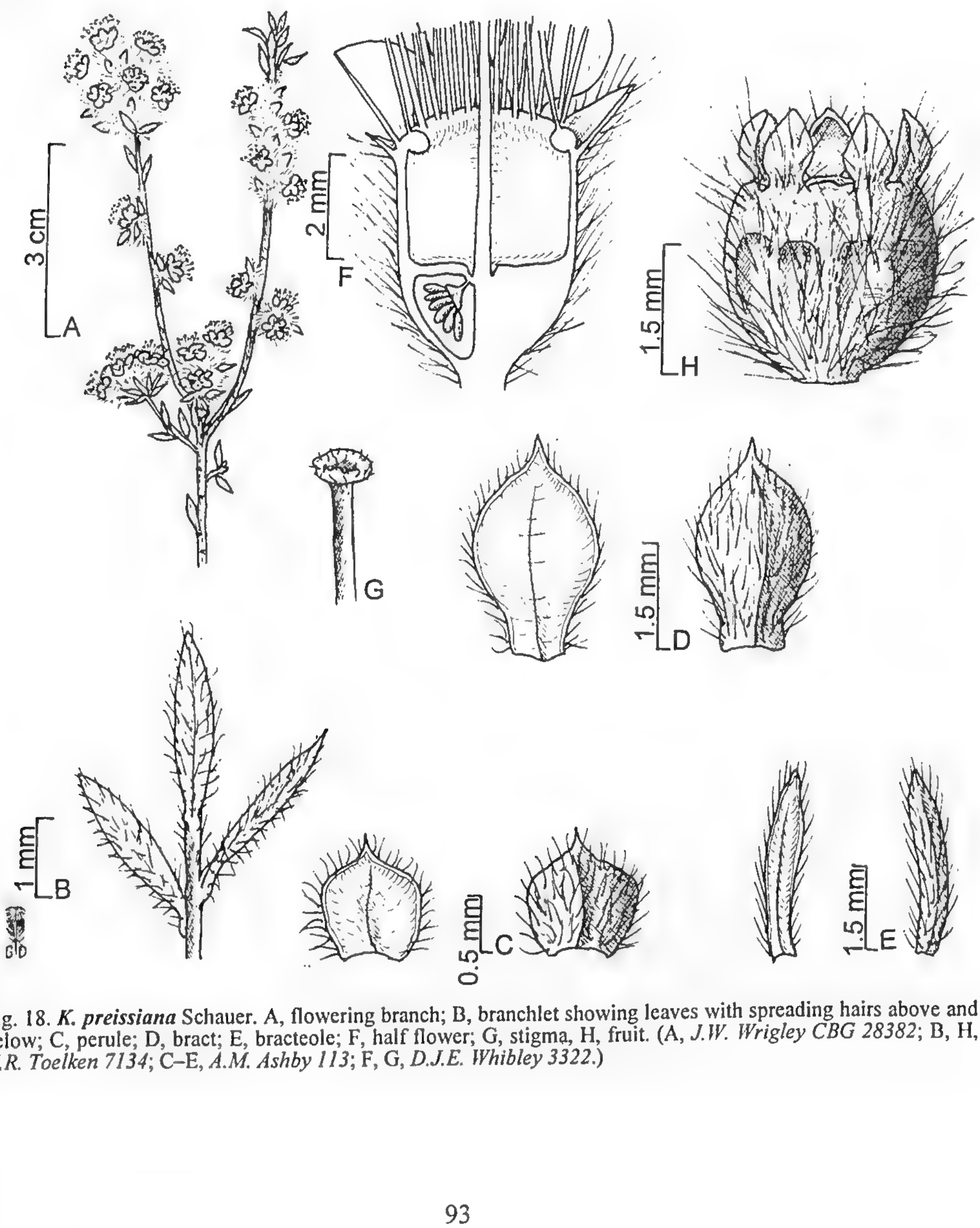


Fig. 18. ***K. preissiana*** Schauer. A, flowering branch; B, branchlet showing leaves with spreading hairs above and below; C, perule; D, bract; E, bracteole; F, half flower; G, stigma, H, fruit. (A, *J.W. Wrigley CBG 28382*; B, H, *H.R. Toelken 7134*; C–E, *A.M. Ashby 113*; F, G, *D.J.E. Whibley 3322*.)

Distribution and ecology

Locally common on usually gravelly lateritic soil on the plain or on gravelly lower slopes; from near Narrogin to near the coast at Albany and eastwards to east of Hopetoun. Map 6.

Conservation status: A widespread species which is often locally common.

Diagnostic features

K. preissiana is distinguished from other species in this subsection by having almost flat leaves with usually spreading hairs on both surfaces, and flowers with bluntly acute calyx lobes. On older leaves the characteristic silky hairs often wear off in parts of one or both surfaces.

It is similar to *K. similis* since the vegetative growth continues terminally above the fruiting inflorescence, but usually without an initial flush of lateral branches, in contrast to short lateral branches that often immediately produce lateral branches, with the result that it produces an intricate branching pattern similar to that found in other species of this subsection. In *K. similis* similar lower lateral branches usually remain vegetative so that it does not produce an intricate branching system.

Variation

This widely distributed species shows much variation often presented as local forms of which the most important ones are:

1. Plants from south of, but also from parts of the Stirling Range, have rather long hairs (up to 1.2 mm long) on flowers and leaves, and have for that reason been described as *K. villiceps*. Although their inflorescences often have more than eight flowers and their petals are often longer than 3 mm, these characters seem to intergrade into those of other forms.
2. To the north of the Stirling Range the plants are less hairy and leaves are usually narrower to linear-oblanceolate as in the type of the species. Within this form the hairs on older leaves often wear off. The bracts are also often lanceolate with a well developed beak.
3. To the north-east of the Stirling Range and especially in the vicinity of Ongerup, the leaves are often small (ca 2.4 mm long) and soon become glabrous.

In the last area the delimitation of *K. preissiana* may seem artificial since its distinction from its hybrids with *K. affinis* and *K. jucunda* become blurred. Both of these hybrids are distinguished here by the young leaves being glabrous or distinctly less hairy on the upper surface and the hairs on the leaves being usually more or less appressed. Most specimens of these hybrids are recognised by some or all calyx lobes being glabrous or glabrescent while in *K. preissiana* hairs are retained on the calyx for a long time. *K. preissiana* has young leaves with more or less spreading hairs of about the same size on the upper and lower surfaces of the leaves. 'Young leaves' are defined here as those on long shoots, mainly so as to avoid the first three leaves of a new branch which are often abnormal in shape, size and tomentum. At present it cannot be fully evaluated whether some natural variation of *K. preissiana* has been included in the circumscription of these two common putative hybrids. There are some localities where they have been found without the presence of both parents, or herbarium specimens have been recorded from localities from where both parents, have not been collected. The delimitation of these two hybrids is, however, based on observations of some populations in the field.

Typification

Both *K. preissiana* and *K. villiceps* were lectotypified here on the basis of specimens annotated in Schauer's hand. The specimen of *K. preissiana* was selected in spite of its absence of flowers, because the long spreading hairs on both surfaces of the leaves leave no doubt about the taxon concerned. No duplicates of these specimens were seen in the present study so they might be a holotype, but equally isotypes could be discovered.

The name *K. preissiana* must be used over *K. villiceps* as Bentham (1867) had established its priority with his combination of *K. preissiana* var. *villiceps* (A.11.6).

Selection of specimens examined (ca 75 seen)

WESTERN AUSTRALIA: *T.E.H. Aplin 2038*, E Cranbrook, 16.x.1962 (AD, MEL, PERTH); *A.M. Ashby 1969*, Red Gum Pass Road, 28.ix.1966 (AD, K, PERTH); *M.A. Burgman 2164 & S. McNee*, 21.5 km SE Muckinwobert Rock, 6.ix.1983 (PERTH); *N.T. Burbidge 2450*, N Pootenup, 11.ix.1947 (CANB); *R.J. Cranfield 1007*, 66 km N Raventhorpe, 4.xi.1978 (PERTH); *Miss Cronin s.n.*, Lake Wagin, -.1890 (MEL); *E.M. Canning CBG 31774*, 35 mls Albany to Borden, 25.x.1968 (CANB); *A.A. Dorrien-Smith s.n.*, Bridgetown to Kojonup and Slab Hut Gully, -.1910 (K); *J. Drummond 3, 39*, Swan River Colony, -.1845 (K, MEL, NSW, PERTH); *H. Eichler 21110*, near Hopetoun, 9.ix.1971 (AD); *J. Galbraith 1064*, Raventhorpe, 16.x.1964 (MEL); *C.A. Gardner 494 (FH 994)*, Gnowangerup, 22.x.1920 (PERTH); *A. Meebold 1124*, Normalup, -.xi.1928 (K, PERTH); *A. Morrison s.n.*, between Yetemerup & Warrungup, 15.x.1902 (PERTH); *F. Mueller MEL 92729*, S. Stirling Range, -.x.1867 (MEL); *E.C. Nelson ANU 16917*, Dryandra State Forest, Narrogin, 10.xi.1972 (PERTH); *A.F. Oldfield 356*, Stirling Range, s.d. (MEL); *M.E. Phillips CBG 19054*, 7 mls S Wagin, 7.x.1962 (CANB, MEL); *J.M. Powell 32833*, 5.3 km NW Boxwood Hill, 16.xi.1985 (AD, NSW); *R.H. Rechinger 59129*, 16 km S Tincurrin, 26.x.1982 (G); *N.H.Speck s.n.*, Esperance, 9.x.1952 (PERTH); *H.R. Toelken 6484*, 12 km NW Gairdner Station, 7.x.1979 (AD, PERTH); *6503*, 30 km S Lake King shop, 8.x.1979 (AD, PERTH); *7132*, NE Bremer Bay, 29.x.1981 (AD, PERTH); *7143*, 12 km NE Boxwood Hill, 30.x.1981 (AD, PERTH); *E.B.J. Smith s.n.*, 146.7 mls along Narrogin-Wagin road, 13.10.1964 (PERTH); *Strid 20893*, 3.5 km N Borden, 22.x.1982 (G, K); *D.J.E. Whibley 3322*, 5 km E Ongerup, 21.x.1969 (AD); *J.W. Wrigley CBG 28382*, 3 mls from Arthur to Williams, 8.x.1968 (AD, CANB).

Putative hybrids

17(i) *K. affinis* × *K. preissiana* see 19(ii) *K. affinis*

17(ii) *K. jucunda* × *K. preissiana* see 18(iii) *K. jucunda*

17(iii) *K. micromera* × *K. preissiana* see 13(iii) *K. micromera*

18. **Kunzea jucunda** Diels, Bot. Jahrb. Syst. 35: 424 (1905); Blackall & Grieve, West. Austr. Wildflow. edn 1, 1: 294 (1954); 'jocunda'; Beard, West Austr. Pl. edn 1: 77 (1965), 'jocunda'; Blackall & Grieve, West. Austr. Wildflow. edn 2, 3A: 99 (1980); J. Green, Census West. Austr. edn 2: 128 (1985).

Type: Western Australia, Mongerup near Salt River, *F.L.E. Diels 4719 (holo.*: B†; *iso.*: PERTH).

K. micromera auct. non Schauer: Benth., Fl. Austr. 3: 114 (1867), as for Gardiner Ranges, *Maxwell 211* (MEL).

Shrubs 0.6–1.2 (–2) m tall, with few stiffly erect stems from the base, each becoming densely covered with many short lateral branches which in turn are usually much-branched; young branches with decurrent flanges, glabrous to sparsely covered with appressed forward-directed hairs especially around inflorescences and terminal buds; early bark fibrous-mosaic, scarcely to well fissured, peeling in long fibrous strips. *Leaves*: *petiole* (0.3–) 0.4–0.7 (–0.9) mm long, appressed; *lamina* elliptic to broadly elliptic, rarely almost orbicular or narrowly elliptic to oblanceolate, (1.2–) 2–2.7 (–3.5) × (0.9–) 1.1–1.5 mm (rarely up to 3 times longer than broad), rounded or bluntly acute, abruptly constricted into petiole, usually concave or rarely flat above, convex below, spreading or more or less appressed when young, glabrous or rarely with a few hairs on lower parts adaxially. *Inflorescence* a botryum with (1–) 2–4 (–6) flowers, terminal mainly on short shoots, with vegetative growth continuing from the terminal bud, rarely from lateral buds below the fruiting inflorescence; *perules* often more than 5, broadly ovate to semi-circular, rounded to

mucronate, rarely cuspidate, with broad membranous margins, with one central vein, marginal cilia often restricted to the lower two-thirds; *bracts* broadly obovate to obovate-spathulate, 1.8–2.2 × 2–2.3 mm, rounded, bluntly acute, rarely mucronate, glabrous or with marginal cilia mainly on the sides, sometimes with a tuft of hairs towards the apex; *bracteoles* in pairs, oblanceolate- to obovate-spathulate, 1.6–2 × 1–1.3 mm long, acute to cuspidate often becoming bluntly acute, with single vein, marginal cilia longer along the sides. *Hypanthium* 2.1–3.2 mm long when flowering (free tube 1.2–1.5 mm long), glabrous. *Calyx lobes* lanceolate, 0.9–1.3 mm long, bluntly acute or rounded, rarely acute, margins slightly incurved, usually not ridged above the main vein, glabrous. *Corolla lobes* orbicular-spathulate, 1.7–2.2 (–2.5) mm long, scarcely clawed, pink to deep mauve. *Stamens* 18–24, usually in two whorls; filaments 2.2–3.2 mm long; anthers with small terminal gland. *Ovary* with 5 locules, surmounted by a broad style base which is scarcely sunk into the surface; placenta narrowly elliptic, scarcely fleshy disc with ascending attachment connected to the upper third, lobes only connate on the outside margins, each lobe with one row of ovules; ovules 7, 8 (–10) per locule, spreading or lower ones pendulous and slightly longer; style 3.1–3.4 mm long, broadened towards the base; stigma discoid to slightly funnel-shaped above. *Fruit* an urn-shaped capsule usually with 5 vertical ridges and erect, slightly incurved calyx lobes. *Flowers*: August–October (November). Fig. 19.

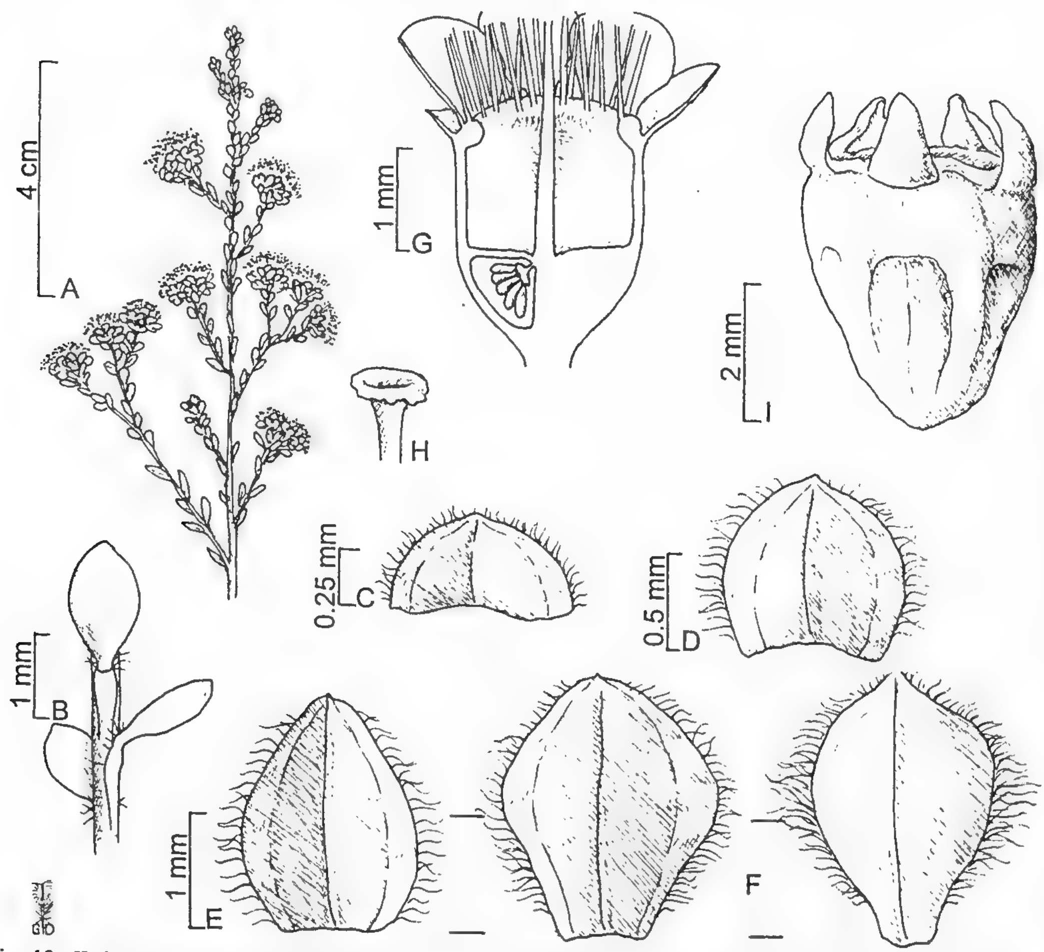


Fig. 19. *K. jucunda* Diels. A, flowering branch; B, branchlet; C, perule; D, lower bract; E, upper bract; F, bracteoles; G, half flower; H, stigma; I, fruit. (A–H, *R.D. Royce 3689*; I, *K. Beamish s.n.*, 2.x.1971.)

Distribution and ecology

Growing usually on sandy but also on rocky soils. It is never common although recorded over a wide range from north-east of the Stirling Ranges near Borden to Lake Magenta, Jerramungup and Bremer Bay, and also near Hopetoun. Map 8.

Conservation status: 3RCa (Briggs & Leigh 1988).

Diagnostic features

K. jucunda is usually easily recognised by its short and broad elliptic leaf blades (up to 3:1), which are glabrous when mature as is most of the plant. The repeated branching of the short lateral branches is very often accentuated by frequent gall development in perennating buds.

Specimens examined

WESTERN AUSTRALIA: *A.M. Ashby 545*, plains north of Stirling Range, 3.x.1963 (AD); *P.H. Barret 7*, Hopetoun Plain, 8.xi.1952 (PERTH); *K. Beamish s.n.*, 10 mls W Ongerup, 2.x.1971 (PERTH); *W.E. Blackall 3087*, S Lake Grace, 23.ix.1933 (PERTH); *M.G. Corrick 7731*, Gairdner River, 5.x.1981 (PERTH); *F.L.E. Diels s.n.*, E of Stirling Range, s.d. (PERTH); *C.A. Gardner s.n.*, West Mt Barren, -.viii.1940 (PERTH); *13729*, near Hamersley River, 24.x.1961 (PERTH); *G.F. Craig 1999*, 11.45 km N Ravensthorpe-Esperance Hwy on West Point Road, 30.viii.1992 (AD, PERTH); *3109*, ca 19 km SSW Ravensthorpe, 18.ix.1994 (PERTH); *R. Hnatiuk 800102*, ca 15 km NE Lake King, 1.x.1980 (PERTH); *F. Lullfitz 3369*, Bremer Bay turnoff on Borden Rd, 16.viii.1964 (KPBG); *3525*, 30 mls W Ravensthorpe, 25.viii.1966 (PERTH); *G. Maxwell 30*, on tributaries to the Salt and Gardner Rivers, s.d. (MEL); *211*, Gardiner Ranges, s.d. (MEL); *R. & E.F. Melville & A.S. George 71.212*, Fitzgerald River National Park, 8.ix.1971 (K); *K. Newbey 6217*, 8km WSW Lake Cronin, 3.ix.1979 (PERTH); *R.D. Royce 3689*, Jerramungup, 13.viii.1951 (PERTH); *6691*, 12 mls W Pingrup, 14.ix.1961 (PERTH); *C.I. Stacey 814*, 27.5 km E Raventhorpe to Esperance, 28.x.1985 (PERTH); *F. Stoward NSW 124064*, Katamung, -.ix.1914 (NSW); *H.R. Toelken 6468*, hill above Toompup H.S., 7.x.1979 (AD); *6487*, 22 km E Jerramungup, 7.x.1979 (AD, PERTH); *6509*, 43 km E Lake King shop, 9.x.1979 (AD, PERTH); *E. Wittwer 186*, m. peg 299 Ravensthorpe Road, 24.ix.1963, (KPBG, PERTH).

Putative hybrids

18(i) *K. affinis* × *K. jucunda* see 19(i) *K. affinis.*

18(ii) *K. cincinnata* × *K. jucunda* see 20(i) *K. cincinnata*

18(iii) ***K. jucunda* × *K. preissiana***

Pericalymma roseum Turcz., Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Pétersbourg 10: 334 (1852); F. Muell., Fragm. 8: 185 (1874); Domin, Mém. Soc. Sci. Bohême (1921) 22, 2: 87 (1923), pro species.

Type: Western Australia, Swan River, *J. Drummond 5, 135* (*holo.*: KW — PERTH, photo.; *iso.*: BM).

K. micromera auct. non Schauer: Benth., Fl. Austr. 3: 114 (1867), partly as for *J. Drummond 5, 135.*

This hybrid is distinguished from *K. preissiana* by its very broad lower bracts (rounded or bluntly acute, rarely mucronate), appressed hairs on the lower surface of the leaves only and some or all calyx lobes glabrous or glabrescent. The broad bracts and the majority of leaves being elliptic and relatively short shows that *K. jucunda* is a probable putative parent. The hairy bracts and hypanthium, which often have spreading hairs (but not always as also in *K. affinis* × *K. preissiana*), indicate that *K. preissiana* is likely to be the other parent. The distinction between this putative hybrid and *K. preissiana* sometimes becomes blurred mainly in a broad area around Ongerup (cf. variation of *K. preissiana*). The very broad bracts, which are stressed above as the main distinguishing feature between this hybrid and *K. affinis* × *K. preissiana* as well as *K. preissiana*, may represent an artificial separation (cf. variation of *K. preissiana*), but can be used as a broad guide to establish the identity of the taxa involved.

Specimens examined

WESTERN AUSTRALIA: *E.M. Bennett 960*, 2 mls E Hamersley River on Ravensthorpe-Esperance road, 12.ix.1966 (PERTH); *B. Doing s.n.*, E Ongerup, 10.ix.1966 (CANB); *J. Drummond 5, 135*, Swan River Colony, —. 1849 (MEL, NSW, PERTH); *C.A. Gardner 12146*, Young River, 30.x.1959 (PERTH); *K. Newbey 501*, 10 mls E Ongerup, 30.ix.1962 (PERTH); *2490*, 7 mls NW Corrigin, 15.x.1966 (PERTH); *A. Strid 20991*, 16 km S Jerramungup, 24.x.1982 (K); *H.R. Toelken 6504*, Lake King, 8.x.1979 (AD, PERTH); *6467*, 1 km S turnoff to Toompup, 7.x.1979 (AD, PERTH); *6468A*, above Toompup H.S., 7.x.1979 (AD, PERTH); *6487*, 22 km E Jerramungup, 7.x.1979 (AD, PERTH); *6502A*, 30 km S Lake King shop, 8.x.1979 (AD, PERTH); *6509A*, 43 km E Lake King shop, 9.x.1979 (AD, PERTH); *7149A*, 20 km N Boxwood Hill, 30.x. 1981 (AD, PERTH); *7167*, 1 km on Toompup Road from Ongerup, 1.xi.1981 (AD, PERTH); *J.H. Willis MEL 15032*, 38 km E Ongerup.

19. **K. affinis** S. Moore, J. Linn. Soc., Bot. 45: 202 (1920); Blackall & Grieve, West. Austr. Wildflow. edn 1, 1: 294 (1954); Beard, West Austr. Pl. edn 1: 77 (1965); Blackall & Grieve, West. Austr. Wildflow. edn 2, 3A: 100 (1980); J. Green, Census West. Austr. edn 2: 128 (1985).

Type: Western Australia, arid plains, Gardner and Fitzgerald Rivers, *G. Maxwell 211* (*holo.*: BM).

K. pauciflora auct. non Schauer: Benth., Fl. Austr. 3: 115 (1867), as for *G. Maxwell s.n.* & s.loc. (MEL 92471, MEL 92472) and 'at base of Mt Bland", *G. Maxwell s.n.* (MEL 92473).

Shrubs 0.6–1.5 (–2.5) m high, with few erect stems each surrounded by an intricate branching system of short branches; young branches with flanges scarcely raised, more or less densely covered with usually appressed forward-directed hairs, becoming glabrous; early bark fibrous-mosaic, scarcely fluted, peeling in long, usually narrow strips. *Leaves*: *petiole* 0.6–0.8 mm long, appressed; *lamina* linear, 3.5–6 (–8) × 0.4–0.8 (–1.1) mm, rounded or rarely with acute apex when young, usually grooved above, strongly convex below, erect to more or less appressed when young, with scattered long forward-directed hairs mainly along the margin. *Inflorescence* a botryum with (1) 2–4 (5) flowers, terminal mainly on short shoots, with vegetative growth continuing mainly from the terminal bud which then often branches immediately, rarely growth is also from one bud below the fruiting inflorescence; *perules*, if present, usually more than 5, often absent on inflorescences with few flowers, broad-ovate, cuspidate to mucronate, with long marginal cilia, woolly outside but often wearing off on exposed surfaces; *bracts* broadly ovate, 1.3–1.6 × 1–12 mm, acuminate, with stiff central veins continued into a mucro or beak, woolly outside; *bracteoles* in pairs, oblanceolate to linear, one usually broader than the other, 1–1.5 × 0.5–0.6 mm, pointed, with one central vein, woolly. *Hypanthium* 2–3 mm long when flowering (with free tube 1.3–1.5 mm long), glabrous. *Calyx lobes* broadly ovate, 1–1.3 mm long, bluntly acute to rounded, rarely acute, margins slightly incurved, a slight ridge above central vein, glabrous. *Corolla lobes* orbicular-spathulate, 2.4–2.8 (–3) mm long, scarcely clawed, pink to magenta. *Stamens* 20–25, in more than one whorl; filaments 2.4–3 mm long; anthers with a small terminal gland. *Ovary* with 5 locules, surmounted by broad style base which is scarcely sunk into the upper surface; placenta narrowly elliptic, scarcely fleshy disc with ascending attachment connected at the upper third, lobes only connate on the outside margins, each lobe with one row of ovules; ovules 8–10 (–12), subequal, spreading or lower ones pendulous; style 3.5–4.2 mm long; stigma discoid to slightly funnel-shaped above. *Fruit* an urn-shaped capsule usually with 5 vertical ridges and erect slightly incurved calyx lobes. *Flowers*: (August), September, October. Fig. 20.

Distribution and ecology

Growing in a wide range of habitats but usually on sandy soils and normally associated with scrub vegetation but also often found in clay soils in depressions or along rivers. Found from east of the Stirling Range, with localities becoming fewer and far between east of Ravensthorpe. Recorded as far north as Lake King and as far south as Cape Riche. Map 7.

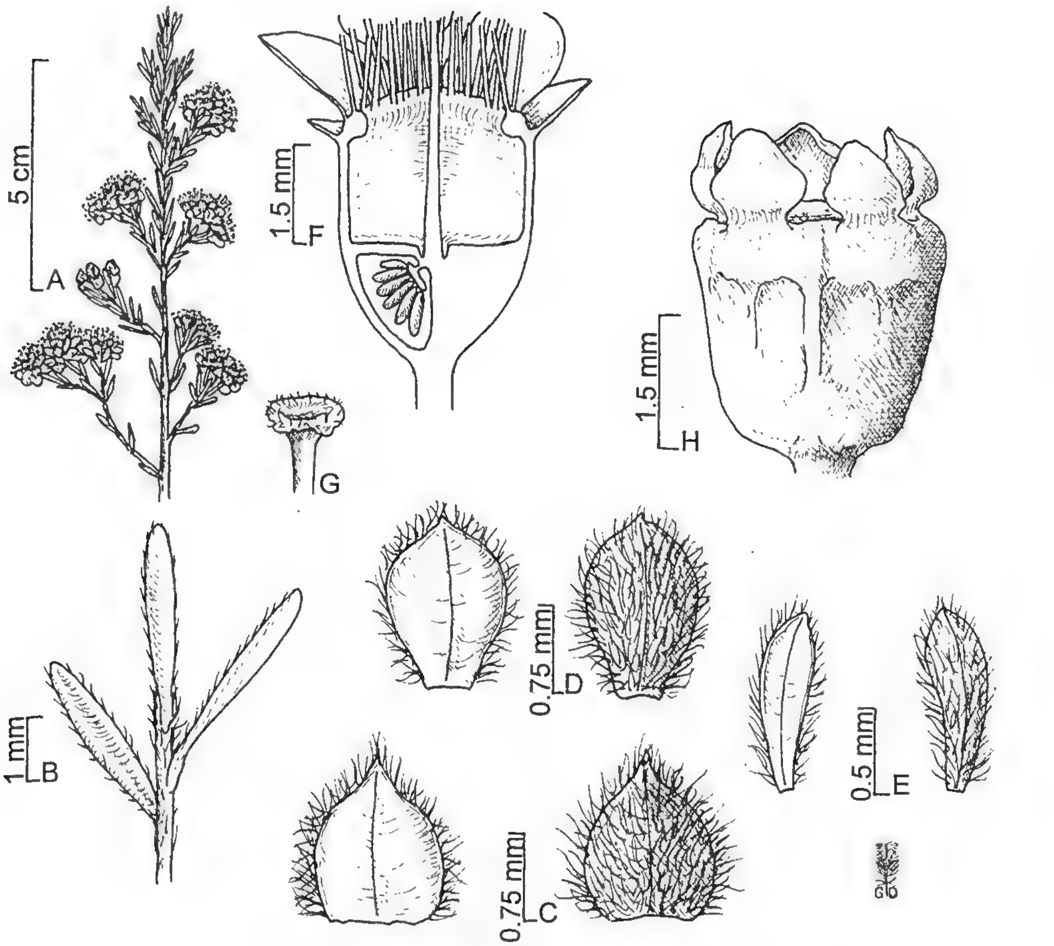


Fig. 20. *K. affinis* S.Moore. A, flowering branch; B, branchlet; C, perule; D, bract; E, bracteole; F, half flower; G, stigma; H, fruit. (A–G, *E. Wittwer 191*; H, *C.A. Gardner & W.E. Blackall 1042*.)

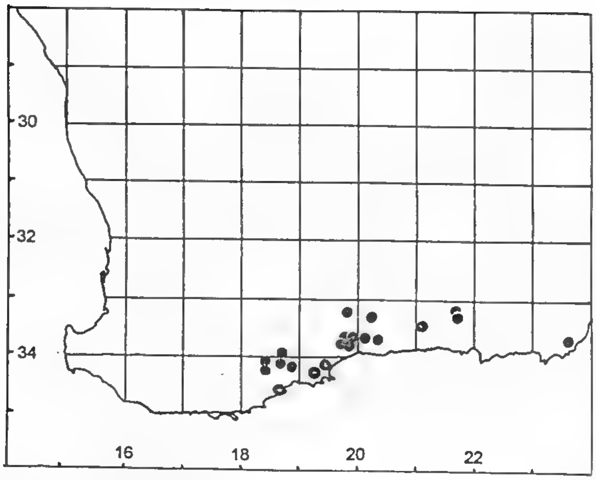
Conservation status: A widespread and locally common species.

Diagnostic features

Kunzea affinis most closely resembles *K. jucunda* in its habit, inflorescences, and frequent galling of apices of branchlets. *K. affinis* has, however, indistinct flanges, the leaves are usually linear, the bracts are densely hairy at least when young, the bracteoles are linear and the flowers usually pedicelled. Occasionally the hairs on the bracts and bracteoles wear off prematurely, but the bracts are acuminate and the young branches have long appressed hairs which distinguish such specimens from *K. affinis* × *K. jucunda*.

The flowers are scented, but this has also been recorded for a few other species in this subsection, although the scent is not obvious.

Bentham (1867) included three *Maxwell* specimens of *K. affinis* under *K. pauciflora* and two of them could be isotypes of the former. However, the latter species is easily distinguished by its habit as well as its long, acute calyx lobes and glabrous bracts which bear only a few marginal cilia.



Map 7. *K. affinis* ●.

Selection of specimens examined (ca 45 seen)

WESTERN AUSTRALIA: *J.S. Beard 7586*, Growellen Road, 28.ix.1975 (PERTH); *E.M. Bennett 2748*, 20 mls W Raventhorpe, 2.ix.1968 (PERTH); *W.E. Blackall 1042*, 4 mls S Truslove, 15.x.1931 (PERTH); *M.A. Burgman 2662 & S. McNee*, 47.5 km W Bald Rock, 3.x.1983 (PERTH); *A.J. Cough 11*, Grass Patch, 18.ix.1962 (PERTH); *G.F. Craig 2078*, 5.4 km S Rollands Road on Edwards Road, 12.ix.1992 (AD, PERTH); *A.R. Fairall 2283*, near Cape Riche, 7.x.1967 (PERTH); *C.A. Gardner 12898*, near Young River, 20.x.1960 (PERTH); *12916*, near Israelite Bay, 21.x.1960 (PERTH); *13999*, Mt Madden, 28.viii. 1962 (PERTH); *E. Gauba 475*, W. Ravensthorpe, 14.x.1955 (CANB); *A.S. George 5725*, Mt Short, 31.viii.1963 (PERTH); *7051*, 30 mls W Ravensthorpe, 30.x.1965 (PERTH); *10954*, W lower Fitzgerald River, 8.ix.1971 (PERTH); *G. Maxwell MEL 92473*, base of Mt Bland, s.d. (MEL); *K. Newbey 506*, 1 mile W Needilup, 30.ix.1962 (PERTH); *L.J. Nunn 328*, 0.2 km from Rockhole Road along Rawlinson Road, 26.ix.1985 (PERTH); *J. Taylor et al. 758*, 56 km ENE Ravensthorpe, 21.ix. 1979 (PERTH); *H.R. Toelken 6474*, 6 km S Toompup H. S., 7.x.1979 (AD, PERTH); *6483*, 12 km W Gairdner Station, 7.x.1979 (AD, PERTH); *7126*, 12 km E Wellstead, 28.x.1981 (AD, PERTH); *7141*, 12 km NE Boxwood Hill, 30.x.1981 (AD, PERTH); *7146*, 20 km NW Bremer Bay, 30.x.1981 (AD, PERTH); *7156*, 19.5 km N Telegraph Road on Hamersley Drive, 31.x.1981 (AD, PERTH); *J. Tonkinson s.n.*, 10 mls E Jerramungup, 8.ix.1965 (PERTH); *F. Uther-Baker s.n.*, Toompup, -.x.1964 (PERTH); *J.H. Willis MEL 92470*, 10 mls W Ravensthorpe, 3.ix.1947 (MEL); *E. Wittwer 191*, 3 mls W Phillips River, 25.ix,1963 (KPBG, PERTH).

Putative hybrids

19(i) ***K. affinis*** × ***K. jucunda***

The hybrid usually superficially resembles *K. affinis* because of its relatively long leaves and very short bracts which are more or less hairy. However, the leaves are never linear and are usually distinctly concave above, the bracts are very broad and are usually rounded or rarely mucronate and the short hairs on young branches are often more or less spreading as in *K. jucunda*.

Specimens examined

WESTERN AUSTRALIA: *D. Clyne NSW 124057*, Raventhorpe to Ongerup, -.x.1969 (NSW); *C.A. Gardner s.n.*, S Ravensthorpe, -.ix.1925 (PERTH); *J. Taylor 758 et al.*, 56 km ENE Ravensthorpe, 21.ix.1979 (CANB); *H.R. Toelken 7162*, 27 km W Ravensthorpe on road to Jerramungup, 31.x.1981 (AD, PERTH).

19(ii) ***K. affinis*** × ***K. preissiana***

K. preissiana auct. non Schauer: Blackall & Grieve, West. Austr. Wildflow. edn 2, 3A: 100 (1980).

K. affinis × *K. preissiana* and *K. jucunda* × *K. preissiana* are quite common and distinguished from *K. preissiana* (spreading hairs on both surfaces of the leaves as well as on bracts and flowers) by appressed hairs on the lower leaf surface (or if rarely on the upper surface in *K. affinis* × *K. preissiana* then the hairs are distinctly shorter than those on the lower) as well as glabrous or glabrescent calyx lobes which often varies from flower to flower. Although *K. affinis* × *K. preissiana* is distinguished from *K. affinis* by a more or less hairy hypanthium and a hairy abaxial surface of the leaves, some specimens superficially resemble *K. affinis* in its linear leaves and very short bracts. This hybrid in its broad circumscription as used here, varies greatly in leaf shape and bracts so as to include those collections more closely resembling plants of *K. preissiana* and *K. jucunda* × *K. preissiana*,

the latter being distinguished mainly by its broad rounded bracts. Consequently, specimens of *K. affinis* × *K. preissiana* are often found to show little resemblance to one another, and a continuous range of characters is only found when a sufficiently large range of material is examined. Such a range is, however, usually not encountered in the field where only a few hybrid plants are found at any locality. While this might be confusing, the range of material examined for this revision did not allow the separation of extreme forms.

Blackall (1980) distinguished *K. preissiana* on the basis of its glabrous calyx lobes combined with rather linear leaves, characters which agree with this hybrid, while the leaves of the very similar *K. jucunda* × *K. preissiana* tend to be broader and elliptic. Although the lectotype of *K. preissiana* is now without flowers, there is no such indication in the protologue, and as the leaves are densely covered with spreading hairs on both surfaces there is no doubt about the application of the name.

Selection of specimens examined (ca 40 seen)

WESTERN AUSTRALIA: *C. Andrews s.n.*, E Stirling Range, -.x.1903 (PERTH); *A.M. Ashby 527*, Borden, 30.ix.1963 (AD); *J.S. Beard 3649*, 12 km E Gairdner River, 18.x.1964 (PERTH); *E.M. Canning CBG 38576*, 1.4 mls SSW Jerramungup, 1.xi.1968 (CANB, PERTH); *R.J. Cranfield 4533*, 9 km SSE Pingelly, 21.x.1984 (PERTH); *A.R. Fairall 2328*, Jerramungup, 9.x.1967 (KPBG, PERTH); *W. Fitzgerald NSW 124067*, E Stirling Range, -.x.1903 (NSW); *C.A. Gardner 9460*, Bendering, 18.x.1949 (PERTH); *C.J. Keighery 1399*, Mt Chudalup, 29.x.1972 (KPBG); *V.F. McDougall 50*, Nyabing, -.x.1956 (PERTH); *K. Newbey 507*, Needelup, 30.xi.1962 (PERTH); *A.E. Orchard 1628*, 32 km NNE of coast of Stokes Inlet, 18.x.1968 (AD, CANB, PERTH); *R.D. Royce 9174*, northern boundery of Fitzgerald River National Park, 21.x.1970 (PERTH); *A. Strid 20991*, 16 km S Jerramungup, 24.x.1982 (G, K); *J. Taylor 1707 & P. Ollerenshaw*, 13 km from Raventhorpe to Hopetoun, 11.ix.1983 (PERTH); *H.R. Toelken 6482*, 23 km W Gairdner Station, 7.x.1979 (AD, PERTH); *6501*, 18 km S Ravensthorpe, 6.x.1979 (AD, PERTH); *7134*, 4km S Qualup H. S., 29.x.1981 (AD, PERTH); *7158*, 19.5 km N Telegraph Road on Hammersley Road, 31.x.1981 (AD, PERTH); *7164*, 27 km W Ravensthorpe on road to Jerramungup, 31.x.1981 (AD, PERTH); *P.G. Wilson 7804*, ca 22 km N Shoal Cape, 25.ix.1968 (PERTH); *E. Wittwer 885*, Wickepin, 22.x.1972 (CANB, PERTH); *2087*, N Chililup, 15.x.1977 (KPBG, PERTH); *J. W. Wrigley CBG 36378*, 72 mls Albany to Jerramungup, 26.x.1968 (CANB, NSW); *D. Young 328*, 45.6 mls W Raventhorpe, 12.x.1967 (KPBG, PERTH).

20. **K. cincinnata** Toelken, *sp. nov.*

A *K. affine* tomento cincinnato in ramis, bracteis longioribus foliis clavatis; a *K. eriocalyx* tomento cincinnato in ramis, ovariis plerumque pentalocularibus quoque 8–10 ovulis differt.

Type: Western Australia. 3 mls SE Ravensthorpe, *J.W. Wrigley CBG 29930* (holo.: PERTH; iso.: CANB).

Shrubs 0.6–1 (–1.5) m tall, with few erect stems and many short lateral branches; young branches with flanges shortly decurrent, pubescent rarely tomentose with more or less coiled or twisted hairs; early bark fibrous-mosaic, scarcely fluted, peeling in long narrow strips. *Leaves*: *petiole* 0.5–0.9 mm long, appressed; *lamina* linear-oblanceolate, rarely linear or linear-elliptic, (2.8–) 3.5–6.4 (–7.3) × 0.7–0.8 (–0.95) mm, bluntly acute, becoming rounded, rarely acute, gradually constricted into the petiole, concave to flat above, usually strongly convex below (but not ridged), erect or rarely spreading at right angles, sparsely covered with coiled hairs on both surfaces. *Inflorescence* a loose botryum with 1–3 (–5) flowers terminal on mainly short shoots, often clustered towards the apex of branches, with vegetative growth continuing from the terminal bud or from lateral buds below the fruiting inflorescence; *perules* few to more than 4, ovate- rarely lanceolate-acuminate, central vein continued into the beak, rarely with 3 veins from the base, with marginal cilia, covered with forward-directed hairs; *bracts* ovate to sometimes elliptic-acuminate, 3–4.5 × 0.6–0.9 mm, similar to perules; *bracteoles* in pairs, linear-lanceolate, 2–3.2 × 0.3–0.6 mm, but often unequally long, acute or bluntly acute, with single vein, with marginal cilia and forward-directed hairs outside. *Hypanthium* 2.8–3.5 mm long when flowering (free tube 1.6–2 mm long), usually villose with forward-directed hairs. *Calyx lobes* ovate to ovate-oblong, 0.9–1.2 mm long, bluntly acute to rounded, with margins slightly incurved, usually not ridged above main vein, pubescent to tomentose, rarely becoming glabrous. *Corolla lobes*

orbicular-spathulate, 2.4–3.2 mm long, pink to deep magenta. *Stamens* 26–34, in more than one whorl, usually scarcely longer than corolla lobes; filaments 2.6–3.4 mm long; anther with small terminal gland. *Ovary* with (3–) 5 locules, surmounted by broad style base somewhat sunk into the upper surface; placenta elliptic to narrowly elliptic, a somewhat fleshy disc with ascending attachment connected to the centre, lobes bulging and connate at the base, each one with 1 or 2 rows of spreading ovules; ovules 8–10 per locule, subequal, spreading, lower ones pendulous and slightly longer; style broadened towards the base, 4–4.5 mm long; stigma discoid. *Fruit* an urn-shaped capsule usually without vertical ridges and spreading calyx lobes. *Flowers*: September, October. Fig. 21.

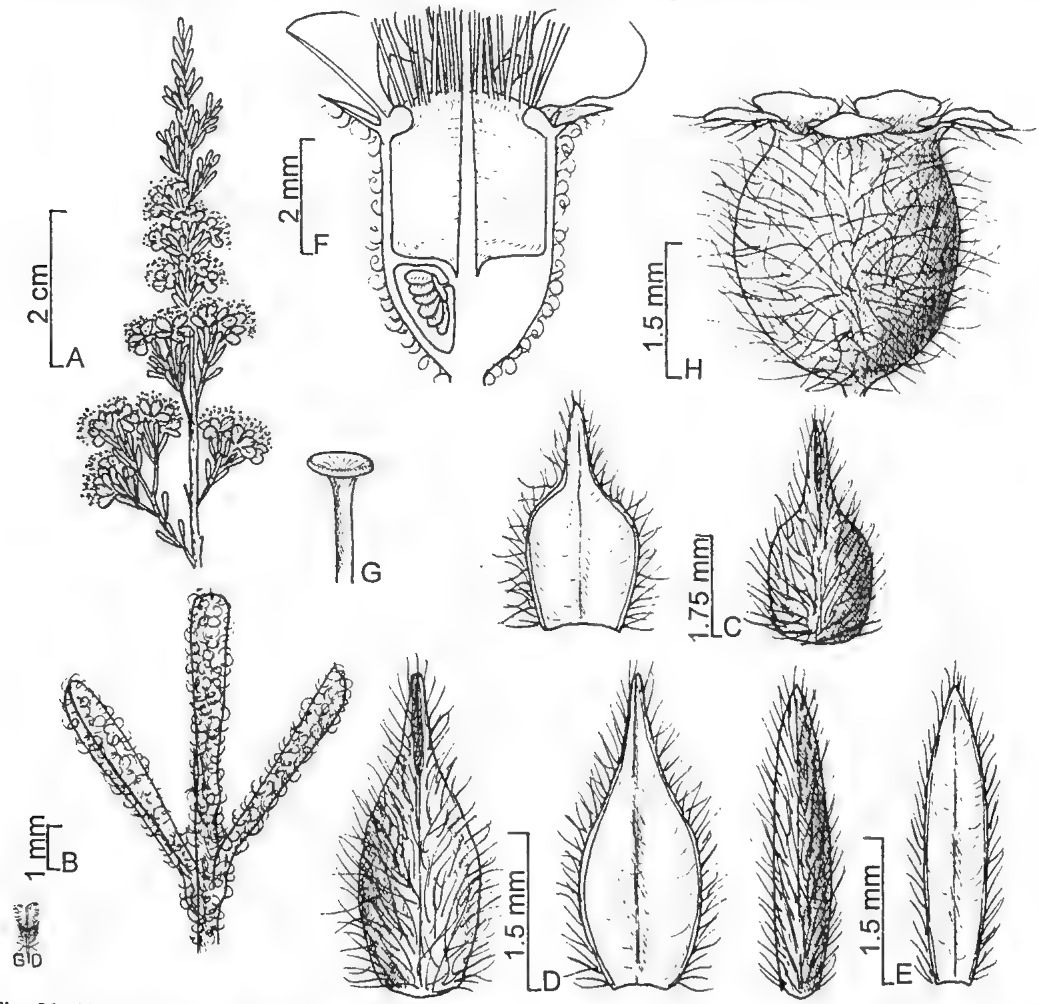


Fig. 21. ***K. cincinnata*** Toelken. A, flowering branch; B, branchlet; C, perule; D, bract; E, bracteole; F, half flower; G, stigma; H, fruit. (A–G, *C.A. Gardner & W.E. Blackall s.n.*, -.xi.1925; H, *A.S. George 1642*.)

Distribution and ecology

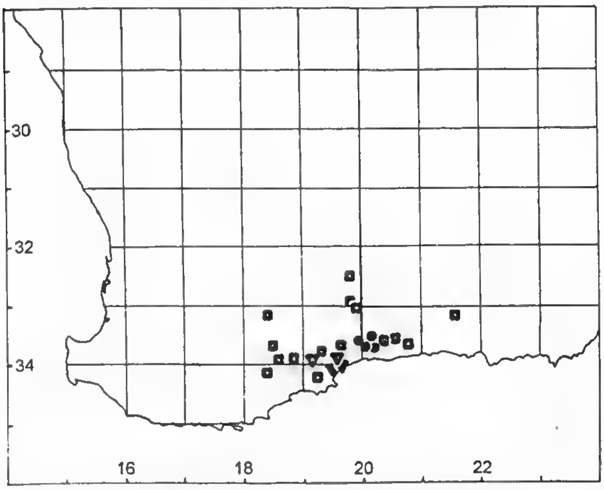
Recorded from 'laterite' and gravelly loam in the mountain ranges near Ravensthorpe. Map 8.

Conservation status

Although only occasionally recorded and from a restricted area it seems to be locally common.

Diagnostic features

Although this species has the typical habit of subsect. *Floridae* it produces predominantly terminal vegetative growth after flowering. Superficially, *K. cincinnata* appears to be a hairy form of *K. affinis* but it is also distinguished from the latter by its larger bracts and bracteoles, which are more than half the length of the hypanthium, and its club-shaped leaves. The hairy flowers and leaves are reminiscent of *K. eriocalyx* which is, however, distinguished by its fewer stamens and an ovary with 2 locules each with 1(2) ovules. *K. cincinnata* could also be confused with hybrids of *K. affinis* and *K. preissiana*, but is distinguished by its coiled hairs and broader perules and bracts.



Map 8. ***K. jucunda*** ◘; ***K. cincinnata*** ●; ***K. eriocalyx*** ▼.

Variation

The tomentum on branches and flowers soon wears off so that it is often reduced or on some parts, particularly the calyx lobes, absent or stubby. The hairs on the inflorescence were only on rare occasions found to be coiled and are usually slightly twisted and spreading. At times even the leaves subtending the inflorescence produce hairs which are not coiled (*C.A. Gardner 12156*).

Etymology: The epithet '*cincinnata*' (has curled hairs, Lat.) refers to one of the distinguishing characters from similar *K. affinis*.

Specimens examined

WESTERN AUSTRALIA: *E.M. Bennett 2499*, Mt Short, 30.viii.1968 (PERTH); *E.M. Bennett s.n.*, Ravensthorpe Range, -.ix.1980 (KPBG); *C.A. Gardner 1895*, Desmond Range, 24.ix.1925 (PERTH); *12156*, Ravensthorpe Range, 1.x.1959 (PERTH); *C.A. Gardner & W.E. Blackall, s.n.*, Desmond Range, -.x.1925 (PERTH); *A.S. George 300*, Ravensthorpe Range, 12.ix.1958 (PERTH); *1642*, E side of Mt Desmond, 14.x.1960 (PERTH); *5724*, Mt Short, 30.viii.1963 (PERTH); *P.G. Wilson 7974*, ca 8 km N Ravensthorpe, 27.viii.1968 (PRETH); *J.W. Wrigley CBG 29930*, 3 mls SE Ravensthorpe, 29.x.1968 (CANB, PERTH).

Putative hybrids

20(i) ***K. cincinnata*** × ***K. jucunda***

The leaves of the two specimens cited below are reminiscent to *K. jucunda* in that they are elliptic, shorter (2.1–3.2 mm long) and early glabrescent, and in addition also the bracts are very broad and glabrescent. However, young branches and leaves are covered with coiled hairs and the bracts are acuminate as in *K. cincinnata*.

Specimens examined

WESTERN AUSTRALIA: *E. Wittwer 381*, 2 mls S of road from Ravensthorpe to Hammersley River, 26.viii.1965 (KPBG, PERTH).

21. **K. eriocalyx** F. Muell., Fragm. 2: 28 (1860); Benth., Fl. Austr. 3: 112 (1867); F. Muell., Syst. Census Austr. Pl. edn 1: 5 (1882); edn 2: 93 (1884); Blackall & Grieve, West. Austr. Wildflow. edn 1, 1: 294 (1954); Beard, West Austr. Pl. edn 1: 77 (1965); Blackall & Grieve, West. Austr. Wildflow. edn 2, 3A: 990 (1980); J. Green, Census Vasc. Pl. West. Austr. edn 2: 128 (1985).

Type: Western Australia, Middle Mt Barren, *G. Maxwell 157* (*holo.*: MEL 92535).

Shrubs 0.5–0.8 (–1) mm tall, with spreading stems sparsely covered with usually short lateral branches each terminating in a cluster of leaves and often an inflorescence; young branches with flanges scarcely developed, covered with long forward-directed and more or less appressed hairs, soon glabrescent; early bark fibrous-mosaic, scarcely fluted, peeling in broad strips. *Leaves*: *petiole* 0.6–1.1 mm long, appressed only at the base; *lamina* linear-oblanceolate (± club-shaped) rarely linear or elliptic, (2–) 2.5–4.5 (–7) × 0.4–0.6 mm, abruptly rounded at apex, very gradually tapering into petiole, flat to slightly convex above, strongly convex below especially near apex (not keeled), stiff-ascending or rarely spreading, glabrous or with appressed forward-directed cilia when very young. *Inflorescence* a botryum with (1–) 3–5 (–7) erect flowers, terminal mainly on short shoots, with vegetative growth continuing mainly from terminal bud or rarely from one to several lateral buds below fruiting inflorescence; *perules* usually few, broadly obovate, cuspidate, with 5–7 veins from the base, with long silky hairs more or less spreading; *bracts* broadly obovate-spathulate, 2.8–3 × 1.8–2.1 mm, cuspidate to acuminate, with 1–3 veins, with long silky hairs more or less spreading; *bracteoles* in pairs, oblanceolate to linear-oblanceolate, 2–2.5 × 0.7–1 mm, acute to acuminate, with single vein, covered with long silky hairs more or less spreading. *Hypanthium* 2.4–3.2 mm long when flowering (free tube ca 1 mm long), densely covered with long, silky, more or less spreading hairs. *Calyx lobes* lanceolate to oblong-lanceolate, 0.8–1.2 (–1.3) mm long, bluntly acute or rounded, margins often incurved and with marginal cilia, densely covered with long spreading hairs. *Corolla lobes* orbicular-spathulate, 1.6–2 mm long, usually with a short broad claw, pink. *Stamens* 11–15, usually in more than 1 whorl, often with gaps in front of corolla lobes; filaments 1.6–2.1 mm long; anthers with small terminal gland. *Ovary* with 2 locules, surmounted by a broad style base which is not sunk into the raised surface of upper surface; placenta broadly elliptic with conical base continued into narrow attachment, lobes almost indistinguishable, forming a ring around a depression with 1 (2) ovules; ovules 1 (2) per locule, equal, pendulous; style slightly broadened towards the base, 2.6–3.2 mm long; stigma small, scarcely discoid. *Fruit* urn-shaped with erect to spreading calyx lobes. *Flowers*: September, October. Fig. 22.

Distribution and ecology

Recorded from "spongolitic loam", "sandy clay over laterite", "in sand" and "among quartzite rocks" in mainly the Fitzgerald River National Park, where it is adequately conserved. Map 8.

Conservation status: 2KCa (Briggs & Leigh 1988).

Notes

A very distinct species distinguished from similar species by its sparsely branched habit, club-shaped leaves, which are aggregated at the tips of branches, few stamens, and 2-locular ovary with 1 (2) ovules in each locule. The lateral branches (short shoot) often have several years of growth and the annual growth is often less than 1 cm.

Specimens examined

WESTERN AUSTRALIA: *C.A. Gardner 9225*, Fitzgerald River, 23.ix.1948 (PERTH); *A.S. George 10958*, W of lower Fitzgerald River, 8.ix.1971 (PERTH); *G. Maxwell 157*, Middle Mt Barren Ranges, s.d. (MEL); *K. Newbey 2762*, near Twertup Creek, between Ongerup & Ravensthorpe, 19.x.1968 (PERTH); *K. Newbey 2879*, 8 mls W Point Charles, 20.ix.1969 (PERTH); *K. Newbey 3444*, 15 mls SW Mt Drummond, 2.x.1971 (PERTH).

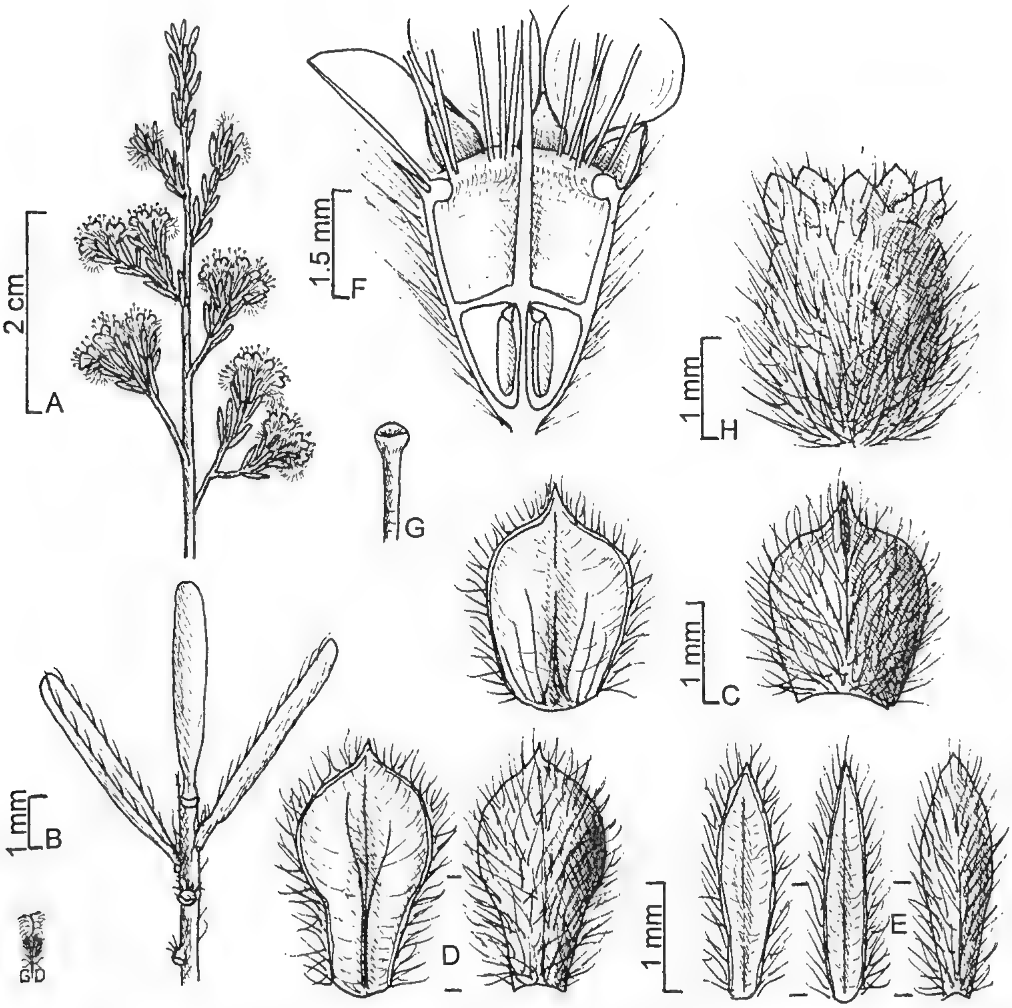


Fig. 22. ***K. eriocalyx*** F.Muel. A, flowering branch; B, branchlet; C, perule; D, bract; E, bracteoles; F, half flower showing 1 or 2 pendulous ovules; G, stigma; H, fruit. (A–G, *K. Newbey 2879*; H, *K. Newbey 2762*.)

Species excluded or insufficiently known

Metrosideros sororia Endl., Enum. Pl. Huegel 49 (1837); Walp., Repert. 2: 165 (1843); Schauer in Lehm., Pl. Preiss. 1: 134 (1844); Benth., Fl. Austr. 2: 114, 154 (1867).

Type: Western Australia, Swan River, *K.A.A. Hügel s.n.* (W, n.v.)

Bentham (1867) suggested that judging by "the characters given" this species should be placed into his broad concept of *K. recurva*, while Schauer (1844) considered it to agree with his *Melaleuca endlicheriana*, which is now generally included in *M. seriata*. As unfortunately no type could be traced in W, it must be assumed the specimen has been placed in another genus and is very likely not a *Kunzea* species. The description in the same publication of the style as simple in contrast to the capitate one in *Metrosideros propinqua* (now *K. ericifolia* susbsp. *ericifolia*) also indicates that *Metrosideros sororia* is not a species of *Kunzea*.

Tetraspora verrucosa Turcz., Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Pétersbourg 10: 405 (1852); F. Muell., Fragm. 8: 185 (1874); Domin, Mém. Soc. Sci. Bohême (1921) 22, 2: 87 (1923).

Type: Western Australia, *J. Drummond 5, 127* (KW - PERTH, photo).

T. verrucosa was placed by Domin (1923) into the synonymy of *K. recurva*, but, like *T. glomerata* (*J. Drummond 5, 117 —Baeckea pentandra* according to F. Muell., Fragm. 8: 183), the specimens show on the photographs long flower stalks (?pedicels) unlike any *Kunzea* species.

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NEW AND INTERESTING SPECIES OF THE FAMILY BRYACEAE (*BRYOPSIDA*) FROM AUSTRALIA

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Abstract

The identity of five Australian species of *Bryum,* listed by Catcheside (1980) as *Bryum species A–E*, has been determined and their taxonomy is discussed. *B. species 'A'* is *B. sullivanii* C. Muell., *B. species 'B'* is *Rosulabryum subtomentosum* (Hampe)Spence, *B. species 'C'*, a new species, is named as *B. eremaeum* Catcheside ex Spence & Ramsay, *B. species 'D'*, also a new species, is named as *B. sabulosum* Catcheside ex Spence & Ramsay while *B. species 'E'* belongs to the widespread taxon *B. dichotomum Hedw.*

Introduction

This paper is published as a memorial to David Catcheside who first discovered the new species and kindly suggested names to us for them prior to his death in June 1994, which predated compilation.

The genus *Bryum* Hedw. (Bryaceae) was revised for Australia and its offshore territories by Ochi (1970) who listed 26 species. Subsequently, additional species have been added (Streimann & Touw (1981), Ochi & Streimann (1987), Ochi (1985), Scott & Stone (1976) and problems in our understanding of certain species have been corrected (Ochi 1972, 1973, 1982, Mohamed 1979). In his treatment of *Bryum* for South Australia, Catcheside (1980) listed five taxa for which he could not find names. These taxa were assigned the letters 'A to E'. Field studies, collection of additional specimens and examination of types and herbarium material of the genus, in preparation for the Flora of Australia, have enabled us to resolve the identities of these five taxa in the light of current taxonomic concepts. Here we provide names, descriptions, distributions and phylogenetic notes for four of the five species. The fifth species (*B. species 'E'.*) was found to belong to the widespread taxon *B. dichotomum.*

Two species (*B. species 'A. & B'.*) have been placed in previously described species although the names accepted by us have earlier been placed into synonymy by others. The other two (*B. species 'C & D'*) have been identified as previously undescribed species and are therefore described here. Section names for *Bryum* follow Ochi (1992).

Bryum sullivanii C. Muell.

Catcheside (1980) described *Bryum species 'A'* as rare, growing on splashed boulders or wet soil over rock along streams, generally at high elevations. He reported it from South Australia and the Australian Capital Territory. Since then, additional collections have extended its range to southeastern Australia and Western Australia (Map 1). Herbarium studies have revealed numerous specimens identified as *B. pachytheca* Hedw. or *B. erythrocarpoides* (C. Muell.)Hampe (= *B. clavatum* (Schimp.) C. Muell.) but which are the same as *B. species 'A'*. Finally, material of *B. sullivanii* from "Erskine River, Lorne, Victoria [no date or collector given]" at H-BR, determined by Brotherus, and type material "*D. Sullivan* from Mt William, Victoria (MEL 1000400)" [see Ramsay & Seur 1994] matched *B. species 'A'*.

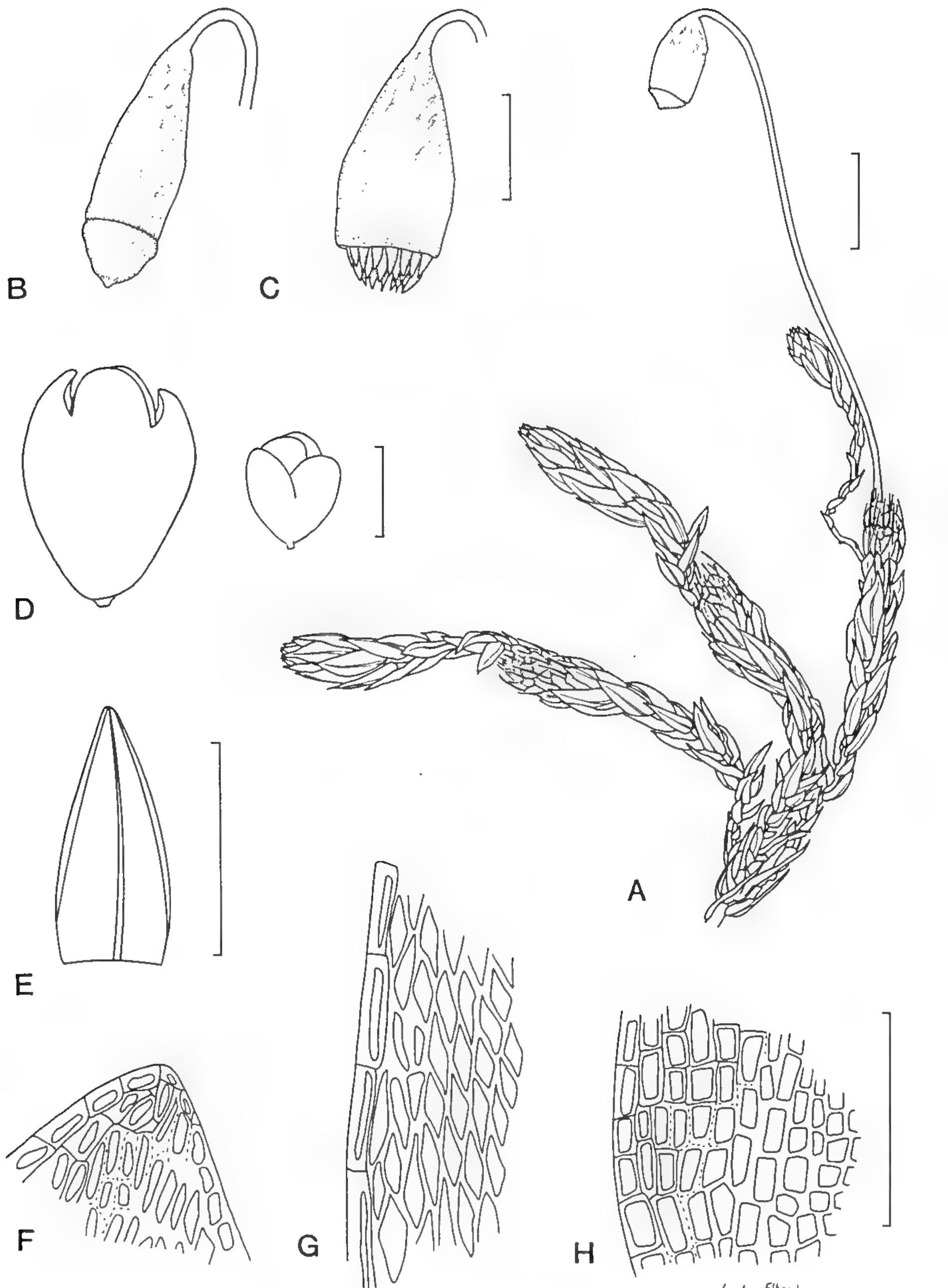

Fig. 1. ***Bryum sullivanii*** C. Muell. **A**, gametophyte bearing sporophyte [*W.A. Weymouth 2706* (AD)]; **B**, capsule with operculum; **C**, capsule showing peristome [**B**, **C**, *D. Sullivan s.n.* (MEL 1000403), Vic. 1883 (MEL)]; **D**, bulbils [H, Brown's River, Tas. (MEL); J.R. Spence 4288 (NSW)]; **E**, leaf; **F**, apical leaf cells; **G**, midleaf cells; **H**, basal cells [**E–H**, *W.A. Weymouth 2706* (AD)]. (Scale bars: A = 2 mm; E = 1 mm; D, F–H = 100 μm).

B. sullivanii has a long and confused history. In New Zealand *B. clavatum* was originally called *B. curvicollum* Mitt. (Sainsbury 1955). Ochi (1970) placed both *B. curvicollum* and *B. sullivanii* into synonymy with *B. erythrocarpoides.* Later this last mentioned species was placed into synonymy with *B. clavatum* of South America by Ochi (1980). We have accepted Ochi's (1980) interpretation for plants in Australasia as *B. clavatum* rather than *B. erythrocarpoides.*

Comparisons between *B. clavatum* and *B. sullivanii* have revealed numerous differences. Perhaps the most striking is the sporophyte. Our understanding of *B. sullivanii* had been based on old or sterile specimens until recently when fresh fertile collections were made. The capsules of *B. clavatum* (Fig. 160, Catcheside (1980)) and *B. sullivanii* (Fig. 1) are strikingly different. That of *B. sullivanii* is short, ovate with a wrinkled thick apophysis, very similar to the capsules of species like *B. pachytheca* and *B. coronatum.* The capsule of *B. clavatum* is elongate-clavate, often remarkably long and somewhat curved, with a slender tapered apophysis. There are many other differences between the species. The leaves of *B. clavatum* are acute, with the costae shortly excurrent as a stout point and the lower margins bordered by elongate thick-walled cells. The leaves of *B. sullivanii* tend to be rounded, often lacking a hairpoint, and the costae are generally percurrent. The tips of younger leaves are often strongly cucullate. The lower margins of the leaves remain unbordered. Another important distinction is in the type of specialised asexual propagules produced by the two species. *B. clavatum* occasionally produces rhizoid tubers, usually found in the tomentum on the stem, while *B. sullivanii* lacks tubers but often produces bulbils, very similar to those produced by *B. dichotomum,* in the axils of leaves.

Because of these differences, we maintain that *B. clavatum* and *B. sullivanii* are distinct species and that *B. species* '*A*' of Catcheside (1980) should be referred to *B. sullivanii* (see Ochi 1970, p. 29, fig. 13; Catcheside 1980, p. 272, fig. 161 and fig. 1 in these studies). In fact *B. clavatum* and *B. sullivanii* are members of separate sections of the genus *Bryum*: *B. clavatum* is in section *Apalodictyon* while *B. sullivanii* is in section *Doliolidium.*

B. sullivanii can readily be distinguished from other members of the section *Doliolidium.* Stems range in size from 2–5 cm or more, often much larger than other species. The habitat, splashed rocks at moderately high elevations, is also different.

Selected specimens examined

AUSTRALIA: WESTERN AUSTRALIA: *J.R. Spence 4249* and *J.R. Spence 4255*, 6.x.1990, Beedelup National Park on damp rocks along creek, Beedelup Falls (NSW); *J.R. Spence 4265,* 6.x.1990, Serpentine National Park, on dry exposed granite near waterfall (NSW); *J.R. Spence 4271*, 8.x.1990, Lesmurdie Falls National Park, on damp partly shaded soil over granite by falls (NSW); *J.R. Spence 4272*, 8.x.1990, Lesmurdie Falls National Park, on dry partially exposed granite rocks near creek below falls, (NSW).

SOUTH AUSTRALIA: *D.E.A. Catcheside,* vii.1988, Bellevue Heights, Adelaide, roof of 72 Eve Road (AD); *J.R.Spence 4288* and *J.R. Spence 4290*, 15.x.1990, Hindmarsh Falls on Myponga-Victor Harbour Rd, wet rock in creek and on soil over rock (NSW); *H. Eichler 12921,* 23.ix.1956, Northern Flinders Range, Gammon Ranges, gorge of western branch of Balcanoona Creek above Loch Ness well (AD); *P. Michell s.n.*, viii.1983 (as *B. sp. A*), Brachina Gorge, Flinders Ranges (AD); *D.G. Catcheside 53.240*, 26.viii.1953 (as *B. sp. A*), on wet rocks by stream, Wilpena Pound, Flinders Ranges (AD); *D.E. Symon s.n.* 14.ix.1964, rocky hill, Waite Institute, Adelaide (AD).

NEW SOUTH WALES: *W.W. Watts 8712,* i.1906, Reservoir Gully, Yarrangobilly Caves (NSW); *A.J. Downing 174,* 23.x.1987, Jenolan Caves, eastern side of Grand Arch, on damp limestone (NSW); *W.W. Watts 8712*, i.1906, Yarrangobilly Caves (NSW).

AUSTRALIAN CAPITAL TERRITORY: *D.G. Catcheside 68.136,* 20.viii.1968, Acton, on soil near Coombes Building, Australian National University (AD).

VICTORIA: *D.G. Catcheside 77.202,* 4.ix.1977, near Hamilton, on soil near the Grange Burn, Dr. McVicker's property (AD); *D. Sullivan s.n.*, 1883, Moyston (MEL).

TASMANIA: *W.A. Weymouth 2706*, 4.xi.1913, Killafaddy Hill, near Launceston, on roadside (AD, NSW); *W.A. Weymouth s.n.*, xi.1892, wet rocks, the Nut, Circular Head (HO).

Rosulabryum subtomentosum (Hampe)Spence

Bryum species 'B' in Catcheside (1980) was considered by him as close to *Bryum billardierei* Schwaegr. [Spelling of *B. billardierei* differs from previous Australian references to this taxon but follows the most recently accepted ICBN ruling that the correct spelling of the author's name be used regardless of the spelling in the original publication]. Ochi (1970) included *Bryum subtomentosum* (Hampe) Hampe as a synonym of *B. billardierei*. Mohamed (1979) annotated the holotype (BM) of *Rhodobryum subtomentosum* Hampe [= *Bryum subtomentosum*] as *B. billardierei* var. *billardierei* but it fits better into *B. billardierei* Schwaegr. var. *platyloma* Mohamed. Recent research, including field studies, shows that *B. subtomentosum* is a separate taxon. Examination of type material, collected from an unknown locality in Australia (BM, MEL) [see Ramsay & Seur 1994], was found to match Catcheside's *Bryum species* 'B'. Comparison with New Zealand material of *B. billardierei* var. *platyloma*, described by Mohamed (1979), revealed that this and *B. subtomentosum* are the same taxon. Thus, *Bryum subtomentosum*, being the oldest validly published name, is accepted and *B. billardierei* var. *platyloma* is placed into synonymy. *Bryum species* 'B' is identified as *B. subtomentosum.*

Recently, Spence (1996) described a new genus *Rosulabryum* to include most members of *Bryum* Section *Rosulata.* Australian species transferred to *Rosulabryum* include species such as *R. billardierei* (Schwaegr.)Spence, *R. subfasciculatum* (Hampe)Spence, *R. albolimbatum* (Hampe)Spence (see Spence 1996 for a complete list of species transfers). *Bryum subtomentosum* is transferred to *Rosulabryum subtomentosum* together with *Bryum billardierei* var. *platyloma.*

Rosulabryum subtomentosum is a robust member of the *R. billardierei* complex distributed in temperate areas of Australasia (Map 2). The species is widespread in New Zealand and its offshore islands. It is common in southeastern mainland Australia and Tasmania and rare in coastal regions of Western Australia. Although very close, *R. billardierei* and *R. subtomentosum* can be distinguished by several characters when used together. *Rosulabryum subtomentosum* has a much thicker leaf border (4–8 layers of elongate thick-walled cells vs 1–2 layers), often imparting a whitish colouration to the margin. The leaves are spathulate in *R. subtomentosum* and obovate in *R. billardierei.* A common habitat of *R. subtomentosum* is splashed rock along streams or near waterfalls, especially at higher montane elevations. In such habitats, the plants can become remarkably elongated (to 10 cm) and pendent from vertical faces. Older stems and leaves often become blackish with age. The setae are hooked just below the capsules (see Mohamed (1979) fig. 5, fig. 2 these studies) in about 90% of *R. subtomentosum* collections but only in 10–20 % of *R. billardierei* specimens.

Selected specimens examined

AUSTRALIA: WESTERN AUSTRALIA: *R. Wyatt & A. Stoneburner 3777*, 27.iv.1984, on sandy soil, track to Reserve Office, Two People's Bay Nature Reserve (PERTH); *R. Wyatt & A. Stoneburner 4090,* 20 vii.1984, Chiddercooping Hill, 43 km N of Westonia (PERTH); *R. Wyatt & A. Stoneburner 3716,* 26.iv.1984, Toolbrunup Park, Stirling Ranges National Park (PERTH); *R. Wyatt & A. Stoneburner 4279,* 16.viii.1984, Mt Chudalup, 17 km S of Northcliffe (PERTH); *D.G. Catcheside 74.123*, 17.iv.1974, Rainbow trail in Karri Forest, Pemberton (PERTH); *D.G. Catcheside 74.291,* 22.ix.1974, base of Bluff Knoll, Stirling Range (PERTH); *D.G. Catcheside 74.179* 18.ix.1974, [as *B. species B*], Cascades near Pemberton (AD).

SOUTH AUSTRALIA: *D.E.A. Catcheside,* 23.ix.1978, [as *B. species B*] south of Ashbourne (AD).

QUEENSLAND: *F.M. Bailey s.n.*, Toowoomba, (BRI); *F.M. Bailey s.n.* Brisbane (BRI).

NEW SOUTH WALES: *D. Camara s.n.*, Richmond River (NSW); *H. Streimann 3962,* [as *Bryum perlimbatum*] Crackenback River, 6 km N.W. of Jindabyne (NSW).

VICTORIA: *J.R. Spence 4366,* 22.x.1990, near Chimney Pots, Grampians, on damp soil and mud over seepy exposed rock face (NSW); *C. French s.n.*, Childers Farm (MEL); *W.W. Watts Vic 1072*, xi.1919, Erskine River, Lorne (NSW).

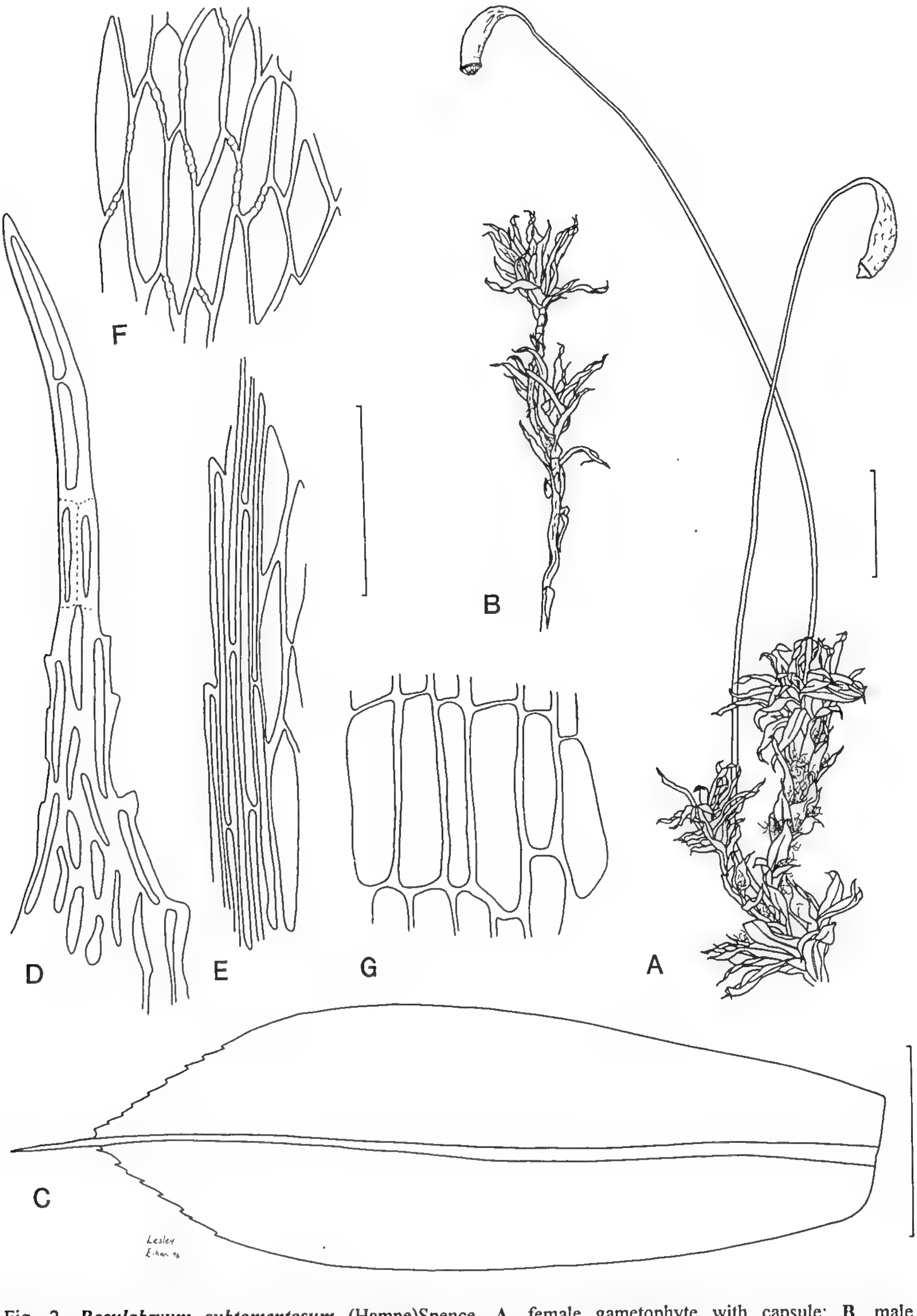

Fig. 2. ***Rosulabryum subtomentosum*** (Hampe)Spence. **A**, female gametophyte with capsule; **B**, male gametophyte; **C**, leaf [**A–G**, *D.E.A. Catcheside s.n.* 23.ix.1978 (AD)]; **D**, apical cells; **E**, marginal cells; **F**, midleaf cells; **G**, basal leaf cells. (Scale bars **A–B** = 5 mm; **D–G** = 100 μm; **C** = 1 mm).

TASMANIA: *J.R. Spence 4691*, 16.xii.1990, Liffey Falls (NSW).

Bryum eremaeum Catcheside ex Spence & Ramsay, *species novum*

B. pachythecae similis sed combinatione characterum sequentium differt: plante dense caespitosae, rubrovirentes, aspectu saepe incana propter aristas apicales foliorum; folia late ovata concavaque, arista apicali longe excurrenti, hyalina dentataque; bulbili frequentes in axillis foliorum in surculis sterilibus, unusquisque primordiis duobus brevibus paxilliformibus per sulcum separatis; tubera ex basi partium subterranearum caulium pullentia.

HOLOTYPE: South Australia: Mirra Mitta Bore, midway between Marree and Birdsville *R.E. Grandison s.n.*, ix.1978 (AD) [*Bryum species* 'C' of Catcheside (1980)].

Dioicous. Plants in dense short tufts, reddish-green, 4–6 mm, often hoary looking because of the hyaline hairpoints. Leaves broadly ovate and concave, 1.5–2.0 mm; margin revolute at least to midleaf; hairpoint long, hyaline and toothed. Upper leaf cells elongate, hexagonal-rhomboidal, 3–4:1; basal cells hexagonal, becoming quadrate at margin, tending to be wider than long. Bulbils common in leaf axils of sterile shoots, one per axil, broadly ellipsoid with two short peg-like primordia separated by a groove. Stem tubers, sometimes present, budding off from the base of underground portions of stems. Calyptrae cucullate. Perichaetia on short basal shoots, perichaetial leaves larger than vegetative leaves. Setae long exserted, 1.5 cm, smooth. Capsules ovate, 2.0 mm, somewhat tapered into setae; apophyses scarcely grooved when moist, but wrinkled when dry; opercula dome shaped, apiculate; peristomes double, exostome teeth 16, lanceolate, yellowish-brown, papillose below, hyaline near tip; endostome of 16 segments, 2/3 to 3/4 length of exostome teeth, broadly perforated; cilia 2–3, appendiculate. Spores 8–15 um.

Proposed by Catcheside (1980) as *Bryum species* 'C', this new species *B. eremaeum* is related to *B. pachytheca*, a widespread Australasian and southeast Asian species in section *Doliolidium*. The two can be distinguished by several features. The bulbils found in leaf axils of the two species are usually present on sterile shoots. Those of *Bryum eremaeum* have small peglike primordia at the apex, with a groove between these (Catcheside 1980, fig. 156; fig. 3 these studies), while those of *B. pachytheca* are smooth and lack the primordia entirely (Catcheside (1980), fig. 155). The distinctive long, white and toothed hairpoint of *B. eremaeum* is very different from the shorter brown, golden or reddish hairpoint of *B. pachytheca.* In Australia *B. eremaeum* is found in South Australia, Victoria and New South Wales (Map 3) while *B. pachytheca* is much more widespread.

This remarkable new species is characterised by two features that are very rare in the genus. Firstly, it is one of few arid-adapted species in *Bryum* and is currently the only known species that is restricted to deserts. Secondly, the presence of stem tubers has only recently been reported for the genus *Bryum* in a single species from Kuwait (El-Saadawi & Zanaty 1990). Although they identified it as *B. bicolor*, it was sterile and may be an undescribed species.

The stem tubers appear to be derived from meristematic activity at or near the stem base (fig. 3), and are reminiscent of potatoes and other true tubers found in flowering plants. We have seen stem tubers in only one other bryaceous species in Australia, *Brachymenium coarctatum*, which occurs in open subtropical forests in Queensland. All three species for which these tubers have been recorded inhabit hot and at least seasonally dry environments. This suggests that stem tubers may be an adaptation for underground vegetative persistence at a site during unfavourable periods of heat and drought. They are much larger than rhizoid tubers, and in the case of *Brachymenium coarctatum* exceed 2 mm in length.

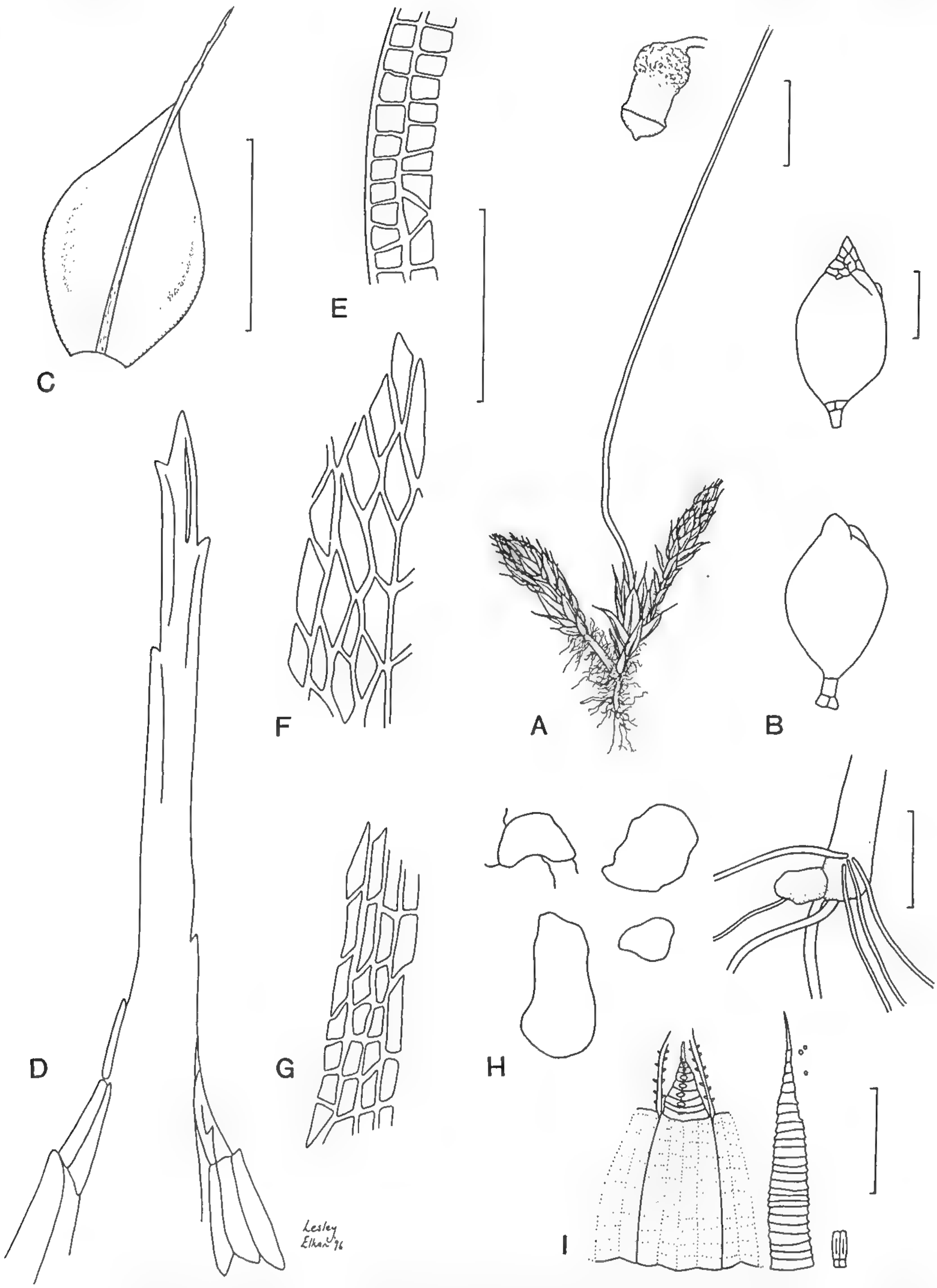

Fig. 3. *Bryum eremaeum* Catcheside ex Spence & Ramsay. **A**, gametophyte with capsule; **B**, bulbils; **C**, leaf; **D**, apical cells; **E**, marginal cells; **F**, midleaf cells; **G**, basal cells; [**A–G**, holotype, *R.E. Grandison s.n.* (AD)]; **H**, stem base with tuber developing, range of shapes of tubers [*D.E.A. Catcheside B4*, Mirra Mitta Bore (AD)]; **I**, peristome [*F.M. Reader* (MEL 30772)]. (Scale bars: **A, H** = 2 mm; **B, D–G, I** = 100 µm; **C** = 1 mm).

Selected specimens examined

SOUTH AUSTRALIA: *D.E.A. Catcheside B1, B4 and B6,* 26.vii.1980, Mirra Mitta Bore (AD); *D.E. Symon L1,* 23.viii.1980, Great Victoria Desert, 40 km W. of Vokes Hill Junction on Connie Sue Highway, slopes of high dune (AD).

NEW SOUTH WALES: *D.G. Catcheside 74.86,* 17.iv.1974, near Euston on soil (AD).

VICTORIA: *A.C. Beauglehole 57179,* 7.ix.1961 (as *B. pachytheca*), Kiata Lowan Sanctuary, in depression mallee area (MEL); *F.M. Reader s.n.*, 19.ix.1894 (as *B. pachytheca*) Sandy Desert (MEL); *A.C. Beauglehole s.n.*, 17.x.1960 (as *B. pachytheca*), roadside 19.3 km S of Ouyen (MEL).

Bryum sabulosum Catcheside ex Spence & Ramsay, *species novum*

B. pachythecae similis sed combinatione characterum sequentium differt: plantae minutae, saepe solitaire inter muscos alios; folia lata ovata, imbricata, aureo-brunnea, marginibus planis vel basi recurvatis; arista apicalis brevis, crassa, laevis aureo-brunneaque; capsulae apophysibus crassis, laevibus vel aliquanto rugosis sed non inflatae ut in *B. pachytheca*; bulbili nulli.

HOLOTYPE: Western Australia: Porongorups, *F.Mueller s.n.* x.1867 (MEL 30812). [*Bryum species D* in Catcheside 1980].

Dioicous. Plants minute 4–5 (-10)mm, brown or golden green, often solitary among other mosses. Leaves broadly ovate, tightly imbricate, 1–1.2 mm, golden-brown, shortly acuminate; margins revolute nearly to apex; costae shortly excurrent. Upper cells hexagonal, 3:1, thick-walled; basal cells quadrate. No bulbils seen. Perichaetia on short basal shoots; perichaetial leaves somewhat larger than vegetative leaves. Calyptrae cucullate. Setae long exserted, 1–1.5 cm, red, smooth. Capsules pendulous, small, 1–1.5 mm long, ovate with thick, apophyses smooth or somewhat corrugate when dry, abruptly tapered to setae; opercula dome-shaped, short-apiculate; peristomes double, exostome teeth 16, lanceolate, yellow-brown, smooth to papillose below; endostome segments about 1/2–2/3 length of exostome, broadly perforated with high basal membrane; cilia 2, nodose. Spores 8-15 um.

Catcheside (1980) described a probable new small species of *Bryum* which he designated as *B. species* 'D', known only from South Australia. He suggested that this species was related to the common widespread *B. pachytheca*, from which it differed in smaller narrower leaves and the smooth to somewhat corrugate apophyses of dry capsules (Catcheside 1980 p. 269, Fig. 4 these studies). Additional collections have been made and this species has been determined as a new species with the name *B. sabulosum.* It is a member of *Bryum* section *Doliolidium.*

Bryum sabulosum has probably been overlooked in the past because of its small size and the tendency to grow as scattered individuals in turfs of other species. Shoots are generally less than 10 mm long, often as short as 4-5 mm. The most distinctive features are the golden-brown, tightly imbricate leaves and the small ovate capsule with a thick, almost smooth apophysis that is somewhat corrugated when dry. So far, no bulbils have been found in this species. In Western Australia *B. sabulosum* occurs most commonly on dry rock outcrops or dry soil pockets on exposed rocks. It is common in the Two Peoples Bay Nature Reserve in the southwestern part of the State. In southeastern Australia it occurs on a variety of substrates including sand dunes (Fig. 4).

Selected specimens examined:

WESTERN AUSTRALIA: *J.H. Willis s.n.,* 3.x.1961, Eyre Highway 9 km N of Norseman, (MEL); *J.R. Spence 4150* (with *B. argenteum),* Petruder Rocks (NSW); *J.R. Spence 4152,* 30.ix.1990 Petruder Rocks on shaded soil near *Eucalyptus sp.* (NSW); *N.N. Donner 2869,* 2.x.1968, Duke of Orleans Bay, Hog Island, estuary of Duke Creek, 65 km E of Esperance (AD, PERTH); *G.G. Smith 285,* 10.viii.1960, Yanchep Park (MEL); *A.C. Beauglehole 14193,* 26.viii.1965, 18 km E of Piawaning, on Wongan Hills Road (MEL); *J.R. Spence 4177,* 3.x.1990, Robinsons Gully, Two Peoples Bay (NSW).

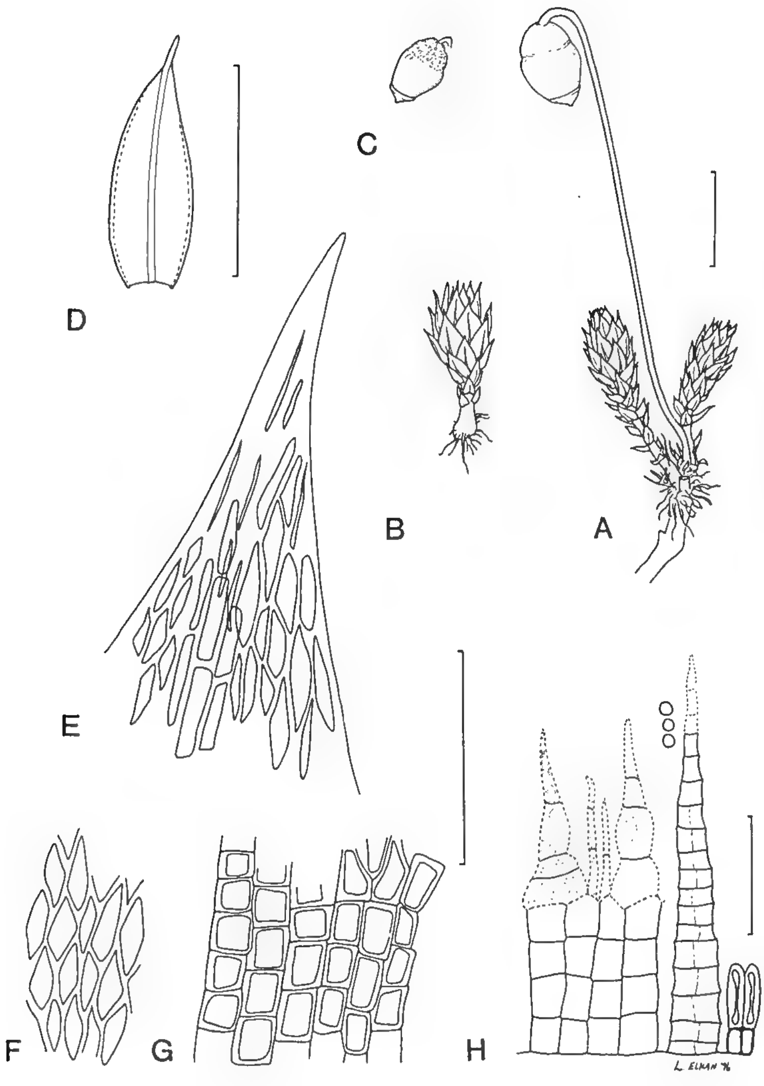

Fig. 4. ***Bryum sabulosum*** Catcheside ex Spence & Ramsay. **A**, gametophyte with young capsule; **B**, sterile plant; **C**, mature capsule; **D**, leaf; **E**, apical cells of leaf; **F**, midleaf cells; **G**, basal cells; **H**, peristome teeth [**A–G**, holotype, *F. Mueller* (MEL); **H**, from Catcheside (1980)]. (Scale bars: **A–C** = 2 mm; **D** = 1 mm; **E–H** = 100 µm).

SOUTH AUSTRALIA: *A.C. Beauglehole 14969,* 26.ix.1965, Eyre Highway 18 km NW of Kyancutta (MEL); *A.C. Beauglehole 15003,* 28.ix.1965, Mambray Creek, Flinders Range (MEL); *J.R. Spence 4324,* 16.x.1990, 3 km E of Athelstone (NSW).

VICTORIA: *I.G. Stone 1694,* 5.x.1969 (with *B. caespiticium),* Whipstick, Bendigo (MELU); *I.G. Stone s.n.,* 29.x.1978, Leigh Creek Gorge (MELU); *D.G. Catcheside 77.148,* 14.ix.1977, near Nigretta Falls, Wannon River near Hamilton (AD); *A.C. Beauglehole 57330,* 9.ix.1961, Roseberry (MEL); *J.R. Spence 4372,* 22.x.1990, Grampians National Park, on damp soil on old stump, Chimney Pot Picnic Area (NSW); *J.R. Spence 4416,* 25.x.1990, Otway National Park, on damp soil near sea cliff, Blanket Bay (NSW).

Bryum dichotomum Hedw.

Bryum species '*E*' of Catcheside (1980) consists of a single collection with a small ovoid capsule, smooth apophysis abruptly tapered to the seta and small red spherical rhizoid tubers. Gametophytically, the plants are very similar to *B. dichotomum* and *B. pachytheca,* although smaller. While the presence of tubers would suggest section *Apalodictyon,* members of section *Doliolidium* occasionally also produce rhizoid tubers (Smith & Whitehouse 1978, Spence 1988). We feel that the specimen in question should be placed in *B. dichotomum* based on leaf and capsule characteristics.

Key to *Bryum* Section *Doliolidium* and related species in Australia

Of the species discussed here, *Bryum sullivanii, B. eremaeum and B. sabulosum* occur in *Bryum* Section *Doliolidium* (C. Muell.)C. Muell. To assist in the identification of these we have provided a key. Couplets to sections *Apalodictyon* of *Bryum* and section *Dicranobryum* of *Brachymenium* are also included as they are closely related to this group.

1 Plants sometimes synoicous or capsules more or less erect and with peristomes reduced .... *Brachymenium* section *Dicranobryum*
1: Plants dioicous, capsules inclined to nutant, peristomes fully developed 2

2 Plants with abundant rhizoid tubers, bulbils absent from leaf axils; capsules elongate-clavate with a long tapered apophysis .... *Bryum* section *Apalodictyon*
2: Plants generally lacking tubers, bulbils often present in leaf axils of sterile shoots; capsules short-ovate with a thick often corrugate or inflated apophysis .... (*Bryum* section *Doliolidium)* 3

3 Stems elongate (>1cm); leaves ovate, cucullate near tip of stem, strongly concave; costae percurrent or not reaching apex; bulbils present, with distinct leafy tips .... *B. sullivanii*
3: Stems mostly short (< 1 cm); leaf shape various, not cucullate, plane or weakly concave; costae generally short to long excurrent into distinct hairpoints; bulbils lacking or if present tips various 4

4. Leaves ovate, widest at middle 5
4: Leaves ovate-lanceolate, lanceolate or triangular, widest below middle 6

5. Costae long excurrent into often hyaline, toothed hairpoints; plants generally with reddish tint; capsule necks corrugate, abruptly contracted to setae; bulbils present, stem tubers sometimes present .... *B. eremaeum*
5: Costae short excurrent, golden-brown; plants lacking red tints; capsule necks almost smooth but corrugate when dry; somewhat tapered to setae; bulbils and stem tubers lacking .... *B. sabulosum*

6 Bulbils with distinct leafy primordia; capsule necks thick and corrugate or smooth and naked, not abruptly contracted to setae 7
6: Bulbils lacking leafy primordia; capsule necks thick, corrugate, abruptly contracted to setae 8

7 Capsule necks smooth, tapered to setae; leaves ovate-lanceolate, margins plane or recurved to midleaf .... *B. dichotomum*
7: Capsule necks thick, corrugate and abruptly contracted to setae; leaves lanceolate or triangular, margins strongly recurved to near apex .... *B. coronatum*

8 Hairpoints usually long and hyaline; bulbils with small peg-like primordia at tip, apices often irregularly grooved between tips; stem tubers sometimes present .... *B. eremaeum*
8: Hairpoints short, coloured, usually golden brown or red; bulbils lacking primordia, apex smooth; stem tubers absent .... *B. pachytheca*

Map 1. ***Bryum sullivanii***

Map 2. ***Rosulabryum subtomentosum***

Map 3. ***Bryum eremaeum***

Map 4. ***Bryum sabulosum***

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ARID LAND *MICROTIS* (ORCHIDACEAE) IN WESTERN AUSTRALIA WITH THE DESCRIPTION OF THREE NEW TAXA

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Abstract

Microtis eremaea, M. graniticola and *M. media* R.Br. ssp. *eremicola* are described as new; illustrations are provided together with a distribution map. Discussion of variation within each species and suspected hybrids is included.

Introduction

Bates (1984) recorded seven species of *Microtis* from Western Australia. Only *M. unifolia sensu lato* was thought to occur in the dry inland. Later, Bates (1990) recognised ten Western Australian *Microtis* and identified three inland species which were treated as *M. media* R.Br., *M. parvifolia* R.Br. and *M. unifolia* (Forst f.)Reichb.f. *sens. lat.*

The type forms of *M. media, M. parviflora* and *M. unifolia* are all plants of high rainfall coastal regions; *M. media* ssp. *media* occurring in south-western Australia, *M. parviflora* in eastern Australia and *M. unifolia* in New Zealand. In view of the very different habitat requirements of plants from semi-arid Western Australia is seemed most unlikely they were the same taxa. The author spent time collecting *Microtis* in Western Australia in 1990 and after re-examining herbarium collections from PERTH and AD concluded that several undescribed taxa were involved, the three best known being here described as new.

New taxa

1. **Microtis eremaea** R. Bates, *sp. nov.*

M. parviflora sensu Bates, J. Adelaide Bot. Gard. 13 (1990) 57.

A *M. pauciflorae* spicibus floralibus rigidioribus, bracteis floralibus longioribus, sepalis dorsalis apiculo erecto, labellique marginibus crenatis differt.

Holotype: 30 km W of Mt Magnet on granite outcrop, 2.ix.1984, *R. Bates 4175* (AD; iso.: AD, CANB, PERTH).

Plants to 40 cm high, moderately slender, rigidly erect, dull green; tuber to 1 cm diam. globular, growing point depressed, new tuber produced distant from plant base. *Leaf* linear, hollow-terete, subtended at soil level by a cylindrical, hyaline sheath to 1 cm long; blade erect, to 50 mm long and 4–7 mm diam., apex rigid or not, fistula not inflated, set at 5–10 cm from soil level. *Flowers* numerous, very small, green, erect in a dense, narrow conical spike to 8 cm long, each subtended by an ovate-lanceolate, acute, pale-edged bract 3–4 mm long; pedicel c. 1 mm long, largely within the floral bract; ovary subcylindrical 3–4 × 1–2 mm, strongly ribbed, not humped near the top. *Dorsal sepal* ovate, 2–2.5 × 1.2 mm shallowly galeate, with a short upturned apiculus, not ribbed. Lateral sepals oblong-lanceolate, c. 2.2 × 1 mm, recurved or revolute. *Petals* oblong, subfalcate 1.5 × 0.8 mm, partly within the dorsal hood. *Labellum* simple, pendulous, cordate, 1.5–2 × 1.2 mm, thick textured, apex subacute, decurved, margins slightly crenulate; basal callus rounded, broader than long, 1 × 0.8 mm, with a broad transverse nectary at its base, apical callus with a slight roughening of the surface. *Column* 1 × 0.8 mm; anther retuse, auricles quadrate, 0.2 mm

long, retuse, stigma crescentic, caudicle 0.2 mm long. *Seeds* 0.02 mm long, pale brown. Fig. 1F–I.

Flowering

August to October; flowers not perfumed. Flowering occurs mostly in seasons of favourable rains and is not dependent on fires.

Distribution and habitat (Map 1)

Widespread throughout semi-arid Western Australia south of 28°, mostly on rock outcrops and along ephemeral watercourses where it may form dense colonies perhaps also in similar habitats in northern South Australia and outback New South Wales.

Related species

Part of the *M. parviflora* complex of very similar species, with tiny simple flowers on rigid stems, differing from other species in having a triangular labellum, with reduced apical callus. *M. eremaea* differs from *M. parviflora sens. strict.* (which is a taxon of summer-damp areas of east-coast forests and swamplands) in the dull, green stiffly erect flower spike, longer floral bracts which are conspicuous early in bud formation, an upturned apiculus on the dorsal sepal, crenulate margins on the labellum and distinctive, broad pit-like nectary. *M. eremaea* is the only member of the *M. parviflora* complex in Western Australia and is apparently the only common *Microtis* throughout vast areas of inland Australia. A very constant species through its western range but further collections from inland South Australia and New South Wales may confirm its occurrence in those states.

Conservation status

Widespread and locally common – not at risk.

Etymology

From '*eremaea*' (Latin) in reference to the preferred arid-land habitat of the species.

Selected collections (from 23 seen at AD)

WESTERN AUSTRALIA: Kodjerning Rock, 14.x.1990, *R. Bates 24092*; Holt Rock, 12.x.1990, *R. Bates 24076*; Newmann Rock, 20.x.1984, *R. Bates 4675*; Woodline via Coolgardie, 2.ix.1916, *J.B. Cleland s.n.*; W of Red Kangaroo Hill, Kalgoorlie, xi.1891, *R. Helms s.n.*

2. **M. graniticola** R. Bates, *sp. nov.*

M. unifolia sensu Bates, J. Adelaide Bot. Gard. 13 (1990) 58.

A *M. unifoliae* floribus depressis, sepalis dorsalis apiculo erecto, labello bifido, calli labelli projectura horizontali caudiculaque crassiore differt.

Holotype: Wave Rock, Hyden, 13.x.1990, *R. Bates 24077* (AD; iso.: PERTH).

Plants 20–50 cm high, slender to robust, wholly green; *tuber* 6–12 mm diam., globular, growing point depressed, new tuber produced distant from plant base. *Leaf* linear, hollow-terete, subtended at soil level by a cylindrical hyaline sheath to 1 cm long; blade erect to 50 cm long and 5–8 mm diam., apex lax; fistula often inflated, set at 5–15 cm from soil level. *Flowers* numerous, large, green, nodding, in a moderately dense spike to 6 cm long, each subtended by an ovate-lanceolate, falcate, acuminate bract c. 6 mm long; pedicel 2 mm

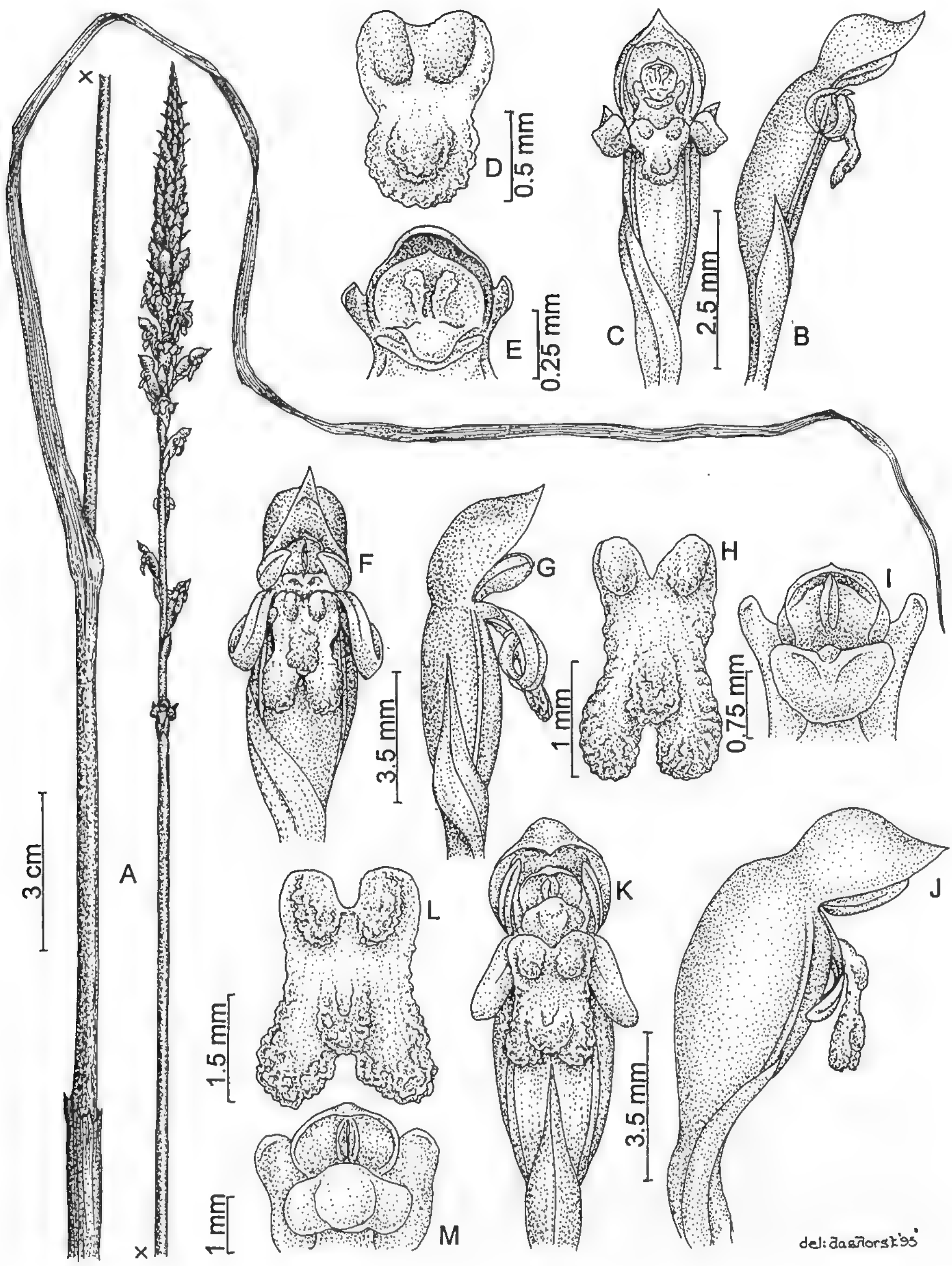


Fig. 1. A–E, ***Microtis eremaea*** R. Bates. A, whole plant; B, flower in side view; C, flower in front view; D, labellum; E, column (*R. Bates* 4175). F–I, ***M. graniticola***. F, flower in front view; G, flower in side view; H, labellum; I, column (*R. Bates* 24077). J–M, ***M. media*** ssp. ***eremicola***. J, flower in side view; K. flower in front view; L, labellum; M, column (*R. Bates* 4670).

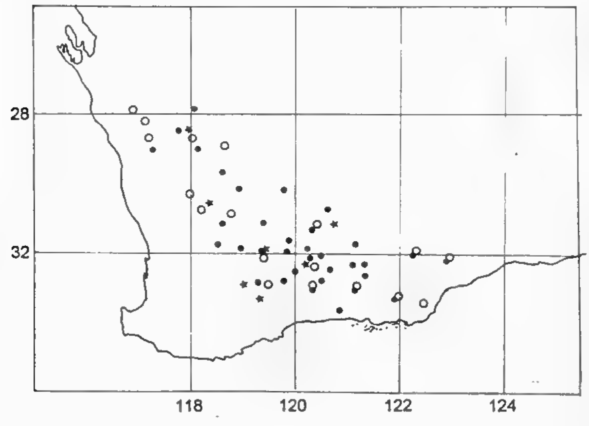
long, largely enclosed within the floral bract; ovary ovoid, 4–5 × 2 mm, humped above, strongly ribbed, with a ring of tubercles at the summit. *Dorsal sepal* ovate, 3–3.5 × 2 mm, with a short straight or upturned apiculus, arched forward, moderately concave below, the margins incurved. *Lateral sepals* short, oblong, 2–2.5 × 1 mm, obtuse, recurved. Petals oblong, subfalcate, 1.8–2 × 0.6 mm, obtuse, largely hidden within the dorsal hood. *Labellum* oblong in outline, c. 3 × 1.4 mm, decurved abruptly near the base, apex bifid, apiculate, margins thickened, undulate, crenulate sometimes papillose; basal calli variable, rounded or oblong never comma-shaped, separated by a deep v-shaped nectary their apices often with a forward projecting, shelf-like thickening; apical callus quadrate, 0.5 × 0.5 mm, cauliflower-like, the apex often decurved. *Column* 1.9 × 0.8 mm, auricles quadrate, 0.4 × 0.4 mm, apex truncate to tridentate; anther retuse, 0.8 mm high, mucronulate; stigma semilunular, caudicle thick, 0.2 mm long. *Seeds* c. 0.08 mm long, pale brown. Fig. 1A–E.

Flowering

September to November; the flowers rarely with a sweet fragrance. Flowering only occurs in seasons of favourable rainfall and is not dependent on fires.

Distribution and habitat (Map 1)

Of sporadic occurrence on larger granite inselbergs throughout drier parts of the wheat-belt and into semi-arid country to the edge of the Great Victoria Desert; mostly occurring as single plants or small groups in deeper soil pockets often with *M. eremaea* or *M. media* and occasionally hybridising with the latter. Possibly extending into South Australia and western New South Wales.



Map 1. Distribution of *Microtis eremaea* ●, *M. graniticola* ★, *M. media* ssp. *eremicola* O in Western Australia.

Distinguishing features

Previously confused with *M. unifolia*, a New Zealand species, which may extend to eastern Australia. *M. graniticola* differs in the more nodding flowers, the bifid labellum, the upturned apiculus of the dorsal sepal, the shelf-like projections to the labellum basal calli, the deeper, distinctive nectary, the cauliflower shaped apical callus and the thicker caudicle. The habitat of *M. graniticola* is also distinctive, whereas *M. unifolia* favours damp woodland and grasslands, *M. graniticola* does not occur outside of semi arid areas where it is confined to granitic inselbergs. *M. graniticola* could easily be confused with *M. media* ssp. *eremicola* with which it seems to intergrade in disturbed areas, but *M. graniticola* has a more concave dorsal sepal, thickened labellum margins without granular excrescences and never has comma-shaped labellum calli.

Variation

In addition to variation caused through hybridising with *M. media* there is a puzzling range of forms which suggest that other species may be involved. Some plants closely approach *M. arenaria* a species common in western parts of South Australia and would

indicate that there may have been natural introductions of that species into the West which have been absorbed through hybridism into local species including *M. graniticola*.

Conservation status: 3RC (cf. Briggs & Leigh 1988).

Etymology

The specific epithet refers to the species preference for granite outcrops; '*graniticola*' (Latin) = granite dweller.

Selected collections (18 seen)

WESTERN AUSTRALIA: Strawberry Rocks, 13.x.1990, *R. Bates 24888* (AD); Geeraning Rock, 14.5 km E of Bonnie Rock, 11.x.1988, *B.H. Smith 1116A* (MEL); Jingemarra, 13.ix.1988, *R.J. Cranfield 6155* (PERTH); Walkaway, 26.ix.1965, *A.C. Burns 6* (PERTH); Woodbine, 17.ix.1935, *J. Cleland s.n.* (AD).

3. **Microtis media** R.Br. ssp. **eremicola** R. Bates, *ssp. nov.*

A ssp. *mediae* labello breviore, labelli marginibus crenatis sine paginae textura granulari et labelli calli basala breviore differt.

Holotype: Newmann Rock, 26.x.1984, *R. Bates 4670* (AD, iso.: AD, PERTH).

Plants slender to robust, 10–50 cm high, wholly green; tuber 6–10 mm diam., globular, growing point depressed, new tuber produced adjacent or distant from plant base. *Leaf* linear, hollow terete, subtended at soil level by a cylindrical, hyaline sheath about 8 mm long; blade erect, to 40 cm long and 5–8 mm diam., apex lax; fistula variable usually 2–10 cm above soil level, not inflated, scape variable according to climatic conditions, usually rather long (5–20 cm). *Flowers* numerous, small, dull green, fragrant, nodding, in a moderately dense subcylindrical spike to 8 cm long, each subtended by an ovate-lanceolate, subfalcate bract 3–4 mm long, apex acuminate; pedicel 1 mm long, enclosed in bract; ovary 4–6 × 2–3 mm, strongly ribbed, tuberculate at the top. *Dorsal sepal* shallow, ovate, 2 × 3 mm, tip acuminate, upturned, margins pale. Lateral sepals oblong, 2.5 × 1 mm, recurved or revolute, apex subacute. *Petals* ovate-lanceolate, 2 × 1 mm, subfalcate, obtuse, partly enclosed in the hood. *Labellum* oblong, 3–3.5 × 1.5 mm, decurved in a semicircle, apex bifid with a distinct apiculus between the lobes, margins crenulate, slightly thickened and with indistinct granular excrescences, basal calli smooth, comma-shaped but not elongate, 0.8 × 0.2 mm, the nectary a transverse W in outline, apical callus quadrate, 0.2 × 0.2 mm, tuberculate. *Column* 1.2 × 1 mm, rounded, the auricles 0.2 mm long, truncate, tuberculate; anther 0.6 × 0.6 mm, mucronulate; stigma 0.8 mm wide, semi-lunular, rostellum short, caudicle 0.2 mm long. *Seeds* 0.04 mm long, pale-brown. Fig. 1J–M.

Flowering

September–November depending on rainfall.

Distribution and habitat (Map 1)

Widespread and locally common especially about rock outcrops throughout the wheatbelt and adjacent interior of Western Australia; also along the edges of ephemeral watercourses and drainage lines. Less common in woodland, mallee, and along roadsides, rarely in swales between semi-arid sandhills or on the edges of salt lakes. Its spread into South Australia would appear to be prevented by the Nullarbor Plain; ssp. *eremicola* does not favour calcareous soils.

Distinguishing features

Ssp. *eremicola* differs from other subspecies of *M. media* in having the labellum margins somewhat crenulate and sometimes thickened but it does sometimes have the granular excrescences typical of the species. The basal calli although comma-shaped as in the other subspecies are much shorter (although the degree of elongation varies from population to population). Most similar to ssp. *quadrata* R. Bates a summer flowered plant from coastal areas which has a deeply concave dorsal sepal and shorter, broader labellum. Resembles some forms of *M. arenaria* Lindley from the eastern states but that species never has comma-shaped labellum calli or granular papillose excrescences. It is possible that ssp. *eremicola* has evolved through hybridisation of *M. media* ssp. *media* with other species, notably *M. graniticola* and perhaps *M. arenicola.*

Key to the subspecies of *Microtis media*

1. Dorsal sepal deeply concave, labellum about as long as broad .... ssp. *quadrata*
1: Dorsal sepal shallow, labellum longer than broad .... 2.
2. Labellum margins slightly crenulate, the papillose excrescences indistinct, basal calli shorter than 1 mm .... ssp. *eremicola*
2: Labellum margins not crenulate, with distinct excrescences, basal calli 1 mm or longer .... 3.
3. Labellum margins with regular excrescences .... ssp. *media*
3: Labellum margins with irregular excrescences .... ssp. *densiflora*

Variation

Varies considerably in size and density of inflorescences depending on rainfall. Size of labellum calli varies from population to population. Some variation probably due to hybridising with other taxa.

Etymology

The epithet *eremicola* (Latin) dweller of dry places referring to the habitat of this subspecies which contrasts to the preferred swampy habitat of the other subspecies of *M. media.*

Conservation status

this is the most abundant subspecies of *M. media* and perhaps the most widespread *Microtis* in Western Australia.

Selected collections (about 45 seen)

WESTERN AUSTRALIA: Wave Rock, Hyden, 13.x.1990, *R. Bates 24687* (AD); Dumbleyung in dry forest, 12.x.1990, *R. Bates 24628* (AD); Orchid Rocks, 29.ix.1990, *R. Bates 23488* (AD); Mount Jackson, 17.x.1983, *G. Bruce 234*, (PERTH); Newman Rocks, 16.x.1984, *C. Stewart 765* (AD).

Acknowledgements

I wish to thank staff at the South Australian State Herbarium particularly G.R.M. Dashorst who drew the illustrations. I am also indebted to staff of CALM (Western Australia) particularly S. Hopper and A. Brown for their support over many years of research in Western Australia. Thanks also to my partner Vanessa for her support.

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THREE NEW SPECIES OF *PHYLLANTHUS* (EUPHORBIACEAE: PHYLLANTHEAE) IN SOUTH AUSTRALIA

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Abstract

Three new species of *Phyllanthus* known to occur in South Australia are described and notes are presented on their distribution, ecology and conservation status: *Phyllanthus oblanceolatus*, *P. erwinii* and *P. striaticaulis*. *Phyllanthus oblanceolatus* is poorly known (3KC) and probably a rare plant with scattered occurrences across the Northern Territory, South Australia and New South Wales. *Phyllanthus erwinii* occurs in rocky localities across central and western arid Australia. *Phyllanthus striaticaulis* (distinct from *P. australis* Hook.f.) is restricted to the Fleurieu and Yorke Peninsulas and also to Kangaroo Island in South Australia. A key to all South Australian species of *Phyllanthus* is presented.

Introduction

The systematics of *Phyllanthus* within Australia has been in turmoil (see Eichler, 1965). Due to the small flowers and comparatively obscure nature of this group of plants, little has been done to clarify species boundaries and nomenclature on a continent-wide basis since Bentham (1873). Additionally, treatments by some authors, such as Airy Shaw (1980), have been overlooked or misread. This has led to inconsistencies in treatments across the country and to confusion as to the status of many species.

This paper presents full descriptions of the three new *Phyllanthus* taxa currently delimited within South Australia by the authors. A key to all South Australian species of *Phyllanthus* is presented, and notes are provided on species treated in South Australian floras that we consider do not occur in this state.

Subsequent papers dealing with new taxa and issues from other states and territories are being dealt with in other Australian herbarium journals. The current paper represents part of our treatment of Phyllantheae of Australia, towards a multi-authored study of the Euphorbiaceae for the *Flora of Australia* (due for completion about 1998).

Comprehensive aspects of affinities and issues of phylogeny are beyond the scope of this paper and we refrain from *ad hoc* discussions of such matters. They will be dealt with after further investigations, in subsequent papers.

The status of *P. saxosus* F. Muell., recorded from South Australia, is still under investigation and this species possibly represents part of a complex within *P. gunnii* Hook.f. Until further investigations are complete, the status of *P. saxosus* as a species has been retained in this paper.

Phyllanthus hirtellus Muell. Arg., although treated by Weber (1986), has not been included in this paper, as no collections have been found that indicate that this species occurs in South Australia.

Methods and Materials

Sampling and organisation of data

Significant proportions of the *Phyllanthus* specimens held by the herbaria AD, BRI, CANB, DNA, HO, MEL, NSW, PERTH and QRS, and historically important *Phyllanthus* specimens from A and GH were provisionally sorted into taxa. Close inspection of these taxa and subsequent re-sorting of specimens formed the basis for our decisions on the status

of these taxa. Ten representative specimens were chosen for detailed analysis of numeric characters. Other characters were scored in all available material. Selection of the ten specimens for study was based on specimen quality in terms of the amount and number of developmental stages displayed. Full variation in character states studied was included, for example, specimens with the longest and shortest leaves seen were scored.

A DELTA (Dallwitz, 1980; Dallwitz *et al.*, 1993) list of 395 characters and their states has been created by the authors for the Phyllantheae (Bruhl & Hunter unpublished). This was used to score attributes measured in selected specimens, together with those measured in all available material.

Fresh material was used where possible, but in most instances floral measurements were based on re-hydrated material. Mature leaves only were used for scoring leaf characters.

Terminology

For purposes of consistency across the members of the Phyllantheae, the perianth segments of *Phyllanthus* are referred to as sepals. Further developmental investigations need to be carried out to confirm this interpretation (Webster, 1993, pers. comm.).

Terminology for seed surface characters follows that of Stearn (1992). A bordered hilum is indicated by a discoloured and often raised region surrounding the hilum (best seen in *P. fuernrohrii* F. Muell.; Fig. 1A, C). Phyllanthoid branching is indicated by a reduction of the leaf that subtends a branch to a scale-like structure (as illustrated by Webster, 1970), care should be taken where leaves may have fallen to check for a leaf scar which will always be present. The term 'prominulous' is as given by Stearn (1992).

Scanning electron microscopy

Seeds were splutter coated with gold using a Polaron E5100 and examined with a JOEL JSM-5800LV scanning electron microscope with a filament voltage of 15 kV.

Citation

Type specimens of all relevant taxa have been seen by one or both of the authors, unless there is an indication to the contrary (i.e. *n.v.*). Photographs of type specimens examined at BM and K are held at NE, together with photographs taken of type specimens on loan to NE.

Specimens are cited with collector and collector number. Where collector number is absent, date of collection is used. If both collector number and date are missing from the sheets the herbarium sheet number is given. Locality statements are direct quotations from labels and are unmodified.

A list of all specimens studied will be deposited at NE. An INTKEY dataset for interactive identification will be made available on completion of our study of the Australian Phyllantheae.

Taxonomy

Phyllanthus oblanceolatus J.T. Hunter & J.J. Bruhl, *sp. nov.*

Phyllanthus australis auctt. non Hook.: Moore, A Census of the Plants of New South Wales: 63 (1884); Moore & Betche, Handbook of the Flora of New South Wales: 74 (1893); Dixon, The Plants of New South Wales: 293 (1906); Maiden & Betche, A Census of New South Wales Plants: 121 (1916); Kalotas, Flora of Central Australia: 192 (1981); Weber, Flora of South Australia 2: 759 (1986) p.p.

Phyllanthus sp. aff. *lacunarius*: J.P. Jessop (ed.) J. Adelaide Bot. Gard.12: 58 (1989) p.p.

Phyllanthus oblanceolatus, species nova similis *P. fuernrohri* F. Muell. a qua planta herbacea glabra, et sepalis et androecioque florum masculinorum minoribus differt.

Holotype: South Australia: Yathong Nature Reserve, 1.6 km north of Arkaroola Memorial gate, *Chinnock 326* (AD). (Upper specimen on sheet.)

Monoecious scandent herb, ca 15 cm high (from only one collection). *Branchlets* ellipsoid to flattened, 3–12.5 cm long, 0.3–0.7 mm wide, glabrous. *Stipules* persistent, free, 1.2–2.5 mm long, chartaceous, entire, glabrous, cream, yellow-brown to red-brown, narrowly triangular to triangular; bases truncate to rounded; apices acuminate to acute. *Leaves* alternate, distichous, jointed, brown when dry or remaining green; *petioles* 0.3–1.6 mm long, 0.2–0.6 mm wide, glabrous; *laminae* symmetrical, plane to concave, 8–19.5 mm long, 2.6–9.6 mm wide, elliptical, obovate to oblanceolate, mid-green, paler below, coriaceous, obscurely veined, glabrous with bases symmetrical, rounded to obtuse, with apices erect, ecaudate, acute, obtuse to rounded, mucronate, with margins plane. *Bracts* and bracteoles deciduous, glabrous. *Inflorescences* borne on persistent branches, at least sometimes with the sexes mixed, indeterminate, axillary, sessile. *Male flowers*: at least sometimes clustered, 1–4 per cluster; pedicels 0.8–5.5 mm long, glabrous; sepals 6, free, ascending to divergent, elliptical to ovate, 0.7–1.7 mm long, 0.4–1.2 mm wide, green and sometimes red tinged, obtuse to acute, chartaceous, glabrous; disk comprising discrete lenticular lobes, 0.6–1 mm wide, glabrous; stamens 3, 1-whorled, symmetrical, erect, filaments free, erect, terete, 0.2–0.6 mm long, anthers extrorse, erect, oblong to elliptical, 0.2–0.5 mm long, the locules parallel. *Female flowers*: at least sometimes clustered, 1–2 per cluster; pedicels jointed, at anthesis 1.1–5.2 mm long, in fruit 2.6–8.5 mm long, 0.1–0.4 mm wide, glabrous; sepals 6, lanceolate to ovate, at anthesis 1–2.7 mm long, in fruit 1.6–3.5 mm, 0.6–1.8 mm wide, free, ascending to divergent, green, with a distinct white margin, obtuse to acute, coriaceous, glabrous; disk crenate, 0.7–1.3 mm wide, glabrous; styles 3, free, variously divided, ascending, green, 0.2–0.7 mm long, 0.1–0.2 mm wide, narrow-terete, glabrous, with branches entire, linear; ovary 0.4–0.9 mm long, 0.5–1.1 mm wide, transversely ellipsoid and apically depressed, smooth, glabrous. *Fruit* a capsule, septicidal, transversely ellipsoid and apically depressed, 1.8–2.8 mm long, 2.5–4 mm wide, green, cartilaginous, glabrous, grooved septicidally; column persistent, angular-ovoid to obconical, 0.8–1.3 mm long. *Seeds* yellow-brown to red-brown and black with age, prismatic, laterally compressed, 1.7–2.1 mm long, 1.3–1.6 mm wide, smooth; hilum markedly depressed, distinctly bordered, circular to ovate, cavity basal. *Flowering*: January to December. *Fruiting*: January to December.

Distribution and ecology

Phyllanthus oblanceolatus has a patchy distribution across the Northern Territory, South Australia and Western New South Wales. In South Australia the species is known from the Gammon Ranges and the far north-western corner. It has also been found in the Macdonnell Ranges in the Northern Territory and the Barrier Range and Yathong near Cobar in New South Wales. Ecological information on herbarium specimens is scant, but collections have often been made along creek banks.

Conservation status: An initial coding of 3KC-NQS (Briggs & Leigh, 1988) is suggested.

Notes

There is only a handful of collections of *P. oblanceolatus*. This could be due to the inaccessibility of the places in which this plant is found. However, until further information is forthcoming this species should be considered rare. *Phyllanthus oblanceolatus* has been mislabelled as many different taxa including *P. australis* Hook. f. (see Weber, 1986 for discussion of the Mt Davies Camp specimen), *P. lacunarius* F. Muell., *P.* sp. aff. *lacunarius*, *P. lacunellus* Airy Shaw, *P. calycinus* Labill. and *Sauropus trachyspermus* (F.

Muell.) Airy Shaw. Morphologically *P. oblanceolatus* is similar to *P. fuernrohrii* F. Muell., but it is easily distinguished from *P. fuernrohrii* by being glabrous (Table 1).

The specific epithet of *P. oblanceolatus* alludes to the distinctly oblanceolate leaves which are common in this species.

Selected specimens

AUSTRALIA: NORTHERN TERRITORY: *Chippendale s.n.*, near Redbank Gorge, Macdonnell Ranges, 10.ix.1958 (DNA); *Weston 13327*, along river near EM-4 well, Mereenie oil lease, east end, (DNA).

SOUTH AUSTRALIA: *Chinnock 326*, Yathong Nature Reserve, 1.6 km north of Arkaroola Memorial gate, (AD); *Bushman 18*, Gammon Ranges National Park, (AD); *Eichler 19624*, Balcanoona, near Nudlamutana Well, (AD); *Cleland s.n.*, Mt Davies Camp, in the Tomkinson Range, 29.vi.1960 (AD); *Spooner 9467*, Bibliando Homestead, (AD); *Barker 496*, Artipena Springs (Martins Well Station), (AD).

NEW SOUTH WALES: *Canning 3653*, ca 2 m from Yathong Homestead towards Cobar, (CBG); *Irvine 1889*, Barrier Range, (MEL).

Table 1. Comparison of selected characters for *P. fuernrohrii* and *P. oblanceolatus*. Measurements in mm unless otherwise stated.

Character	*Phyllanthus fuernrohrii*	*Phyllanthus oblanceolatus*
Plants	glabrescent to indumented	glabrous
Lamina midrib	abaxially raised	flush
Plant height	0.15–1 m	ca 0.15 m
Branchlets	rounded ellipsoid	ellipsoid to flattened
Male flowers	1–7 per axil	1–4 per axil
Male sepal width	1.3–2.5	0.4–1.2
Male disc width	1–1.4	0.6–1
Female pedicel length at anthesis	0.5–3.2	1.1–5.2
Filaments	free to connate	free
Filament length	0.6–1.3	0.2–0.6
Style length	0.6–1.3	0.2–0.7

Phyllanthus erwinii J.T. Hunter & J.J. Bruhl, *sp. nov.*

Phyllanthus lacunarius F. Muell. var. *deuterocalyx* Gauba, Victorian Nat. 65: 184 (1948).

Type: Mt Squires, Barrow Range, W.A., *R. Helms*, 23.9.1891 (holo: MEL).

Phyllanthus lacunarius auctt. non. F. Muell.: Kalotas in J. Jessop (ed.) Flora of Central Australia: 191 (1981); Lazarides & Hince, CSIRO Handbook of Economic Plants of Australia: 188 (1993); Henderson & Forster, Queensland Vascular Plants: Names and Distributions: 115 (1993); Latz, Bushfires and Bushtucker: 244 (1995) p.p.

Phyllanthus lacunellus auctt. non Airy Shaw: Airy Shaw, Kew Bull. 35: 387 (1981); Green, Census of the Vascular Plants of Western Australia edn 2: 108 (1985) p.p.

Phyllanthus erwinio, species nova similis *P. lacunello* Airy Shaw a qua foliis apice rotundato, et ramulis ovariis et fructibus laevibus differt.

Holotype: Northern Territory: Elkedra Station, jump up, 32 km towards Hatches Creek, prostrate herb on recently burned rocky country, *Henshall 2744*, 10.viii.1979 (DNA). (Upper specimen on sheet.)

Monoecious perennial herb, 0.05–0.2 m tall. *Branchlets* rounded, 3.5–9 cm long, 0.4–0.8 mm wide, glabrous or scabrous in longitudinal rows up the stem. *Stipules* persistent, free, 0.9–2.7 mm long, membranous, with a distinct white margin, entire, glabrous, cream to yellow-brown, narrowly triangular; bases truncate to rounded; apices acuminate. *Leaves* alternate, distichous, jointed, brown when dry or remaining green; *petioles* 0.5–1.5 mm

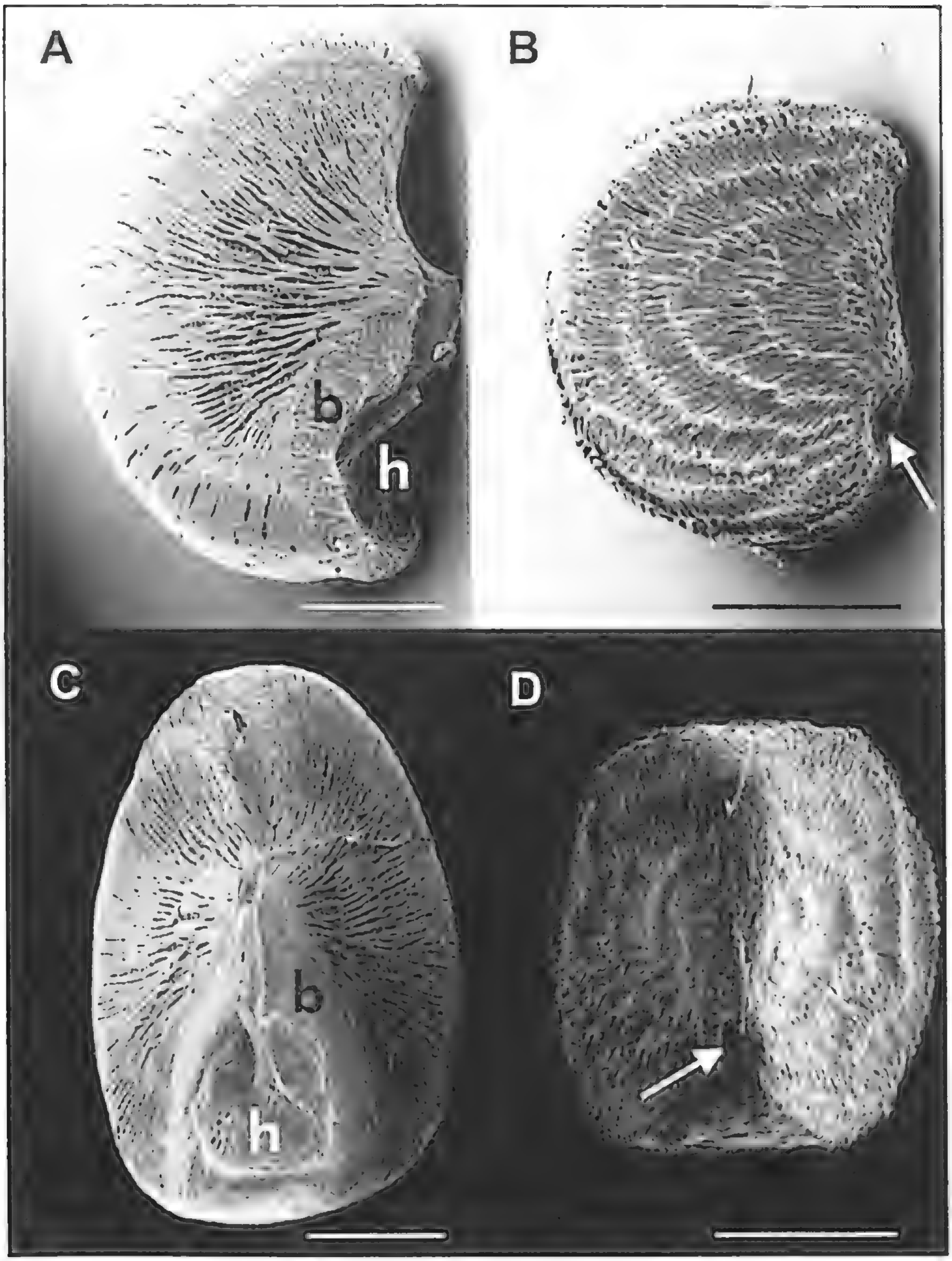

Fig. 1. Scanning electron micrographs of seeds of *Phyllanthus*. A, C, *P. fuernrohrii* F. Muell., the hilum (h) is markedly depressed and distinctly bordered (b), B, D, *P. erwinii* J.T. Hunter & J.J. Bruhl, the hilum (arrows) is slightly depressed. Scale bars = 0.5 mm. (A, C from *Jackson 2773* AD; B, D from *Henshall 2744* DNA).

long, 0.2–0.4 mm wide, glabrous; *laminae* symmetrical, plane to concave, 7.1–23.5 mm long, 2.7–6 mm wide, obovate to oblanceolate, grey-green, sub-coriaceous, abaxially minutely papillate or smooth, occasionally glabrous, more commonly scabrous, abaxially and on the margins, bases symmetrical, cuneate to attenuate, apices erect, ecaudate, rounded, mucronate, with margins plane; midrib abaxially raised with 3–4 veins on either side when identifiable. *Bracts* and bracteoles deciduous, glabrous. *Inflorescences* borne on persistent branches, the sexes mixed, indeterminate, axillary, sessile. *Male flowers*: at least sometimes clustered, 1–3 per cluster; pedicels 0.6–1.4 mm long, glabrous; sepals 6, free, ascending to incurved, ovate to obovate, 0.6–1.4 mm long, 0.5–0.9 mm wide, white, sometimes tinged red, elliptical to circular, truncate to acute, membranous to chartaceous, glabrous; disk comprising discrete lenticular lobes, 0.4–0.7 mm wide, glabrous; stamens 3, 1-whorled, symmetrical, declinate, with filaments free, erect, terete, 0.1–0.3 mm long, with anthers extrorse, ascending, oblong, 0.1–0.3 mm long, anther locules parallel. *Female flowers*: only solitary; pedicels jointed, at anthesis 0.3–0.8 mm long, 0.1–0.2 mm wide, in fruit 0.8–2 mm long, 0.2–0.3 mm wide, glabrous; sepals 6, 0.5–2.4 mm long, 0.2–0.9 mm wide, elliptical, lanceolate to ovate, at anthesis ascending to divergent, in fruit divergent to reflexed, white, green or yellow, obtuse to acute, coriaceous, glabrous; disk crenate, 0.4–0.9 mm wide, glabrous; styles 3, free, divided for about half or much more of their length, divergent, white sometimes tinged pink, 0.1–0.5 mm long, 0.1–0.2 mm wide, linear, glabrous, branches entire, linear; ovary 0.3–0.6 mm long, 0.4–1 mm wide, transversely ellipsoid, apically depressed, verrucose, glabrous. *Fruit* a capsule, septicidal, transversely ellipsoid apically depressed, 1.2–1.6 mm long, 2.4–3.2 mm wide, green turning grey with age, cartilaginous, verrucose, glabrous, grooved septicidally; column persistent, conical to broadly barrel shaped, 0.3–0.7 mm long. *Seeds* yellow-brown, red, pallid-brown to red-brown, prismatic, laterally compressed, 1–1.3 mm long, 0.9–1.3 mm wide, prominently rugose; hilum slightly depressed (Fig. 1B, D), circular, cavity basal. *Flowering*: April to October. *Fruiting*: April to October.

Distribution and ecology

Phyllanthus erwinii has a widespread and disjunct occurrence across western and central arid Australia, from Shark Bay and Derby in Western Australia through the Northern Territory and just over the border into South Australia. This species has been found in grassy woodlands, arid shrublands and tussock grasslands in central Australia on rocky ground along ephemeral watercourses in sandy and clayey soils. Few collections have been made of this species, but this probably reflects the remoteness of locations from which it has been found.

Notes

Phyllanthus erwinii is similar to, but morphologically and geographically distinct from *P. lacunarius* and *P. lacunellus* (Table 2). Gauba (1948) described *P. erwinii* as *P. lacunarius* var. *deuterocalyx*. Airy Shaw (1980) subsequently included this entity within *P. lacunellus*. With the proper circumscription of *P. lacunellus* and the recognition of *P. erwinii*, *P. lacunarius* now becomes uncommon and probably rare in South Australia.

Most specimens of what we recognise as *P. erwinii* have been identified *as P. lacunellus*, while specimens of *P. lacunellus sensu stricto* either have been left undetermined or misidentified as *P. lacunarius*. For discussion of *P. lacunellus and P. lacunarius* see Airy Shaw (1981).

The specific epithet commemorates Erwin Gauba, Australian botanist (1891–1964), who first recognised this entity at the rank of variety.

Selected specimens

WESTERN AUSTRALIA: *Newbey 10715*, 22 km SE of Quarry Hill, ca 105 km of Tom Price, (PERTH); *Cranfield 5358*, No. 4 Well, Erong Springs Station, (PERTH); *Meadly 134*, Manberry Stn, NE of Carnarvon, (PERTH); *George 8288*, Pass of the Abencerrages, Rawlinson Range, (PERTH); *Anon.*, Greenoughs River, xi.1877, (MEL); *Gauba 1941* (PERTH).

NORTHERN TERRITORY: *Henshall 2744*, Elkedra Stn, jump up 32 km towards Hatches Creek, (DNA); *Latz 4887*, Simpsons Gap National Park, (DNA); *Latz 8798*, Gully above Reedy Rock Hole, (DNA); *Latz 8825*, 1 km west of Reedy Rockhole, (DNA).

SOUTH AUSTRALIA: *Kuchel 368*, Gorge on north-east of Mt Woodroffe in Musgrave Ranges, (AD 01639153).

Table 2. Comparison of selected characters for *P. lacunarius*, *P. lacunellus and P. erwinii.*

Character	*Phyllanthus lacunarius*	*Phyllanthus lacunellus*	*Phyllanthus erwinii*
Plant height	ca 0.3 m	0.4–0.6 m	0.05–0.2 m
Branchlets	ellipsoid to flattened, not ribbed	rounded, ribbed	rounded, not ribbed
Branching	phyllanthoid	not phyllanthoid	not phyllanthoid
Lamina apex	rounded	obcordate to emarginate	rounded
Flower number	1–2 per axil	1–2 per axil	1 per axil
Sepal margin	distinct and white	distinct and white	indistinct
Ovary & fruit	smooth	smooth	verrucose
Seed sculpture	striate	rugose to ribbed	rugose
Extra-hilum lateral depression	not present	present	not present

Phyllanthus striaticaulis J.T. Hunter & J.J. Bruhl, *sp. nov.*

Phyllanthus australis auctt. non Hook.: Tate, A Handbook of the Flora of Extratropical South Australia: 40 (1890); Black, Flora of South Australia 2: 511 (1963); Weber, Flora of South Australia 2: 759 (1986).

Phyllanthus striaticaulis, species nova similis *P. australe* Hook. f. a qua floribus albis usque viridibus, pedicellis longioribus, et fructibus angustioribus differt.

Holotype: South Australia: Kangaroo Island, near American River (Town) at the road to Kingscote, 13.xi.1958, *Eichler 15481* (holo [male, right specimen on sheet]: AD; iso: AAU *n.v.*, CANB, E *n.v.*, GH *n.v.).*

Dioecious perennial herb, 0.05–0.6 m tall. *Branchlets* persistent, rounded to angular, prominently ribbed, 6–27 cm long, 0.04–1.4 mm wide, glabrous to papillose. *Stipules* persistent, free, 0.5–1.1 mm long, red-brown or black, membranous, entire to erose, glabrous, ovate, base truncate to cordate, apex acuminate to acute. *Leaves* alternate, distichous, jointed; *petioles* 0.5–1.1 mm long, 0.3–0.6 mm wide, glabrous; *laminae* symmetrical, concave, 6.3–12.5 mm long, 1.9–4.2mm wide, elliptical, lanceolate, obovate to oblanceolate, light-green to mid-green, sub-coriaceous, obscurely veined, glabrous or papillose, with bases symmetrical, obtuse and attenuate, with apices erect to recurved, ecaudate, acute to rounded, mucronate, often reddish, sometimes becoming callused, margins plane, thickened; midrib and lateral veins abaxially raised. *Bracts* and bracteoles deciduous, glabrous. *Inflorescences* borne on persistent branches, indeterminate, axillary, sessile. *Male flowers* at least sometimes clustered, 1–4 per cluster; pedicels 1.8–6.9 mm long, glabrous; sepals 6, free, ascending to divergent, ovate to obovate, 1.2–2.2 mm long, sepals 0.8–1.4 mm wide, white or green, elliptical, oblong, rounded to acute, sepals membranous to chartaceous, glabrous; disk comprising discrete lobes, 0.9–1.7 mm wide, glabrous, lobes lenticular; stamens 3, 1-whorled, symmetrical, erect to declinate; with filaments free, erect, terete, 0.4–0.8 mm long; with anthers extrorse, ascending, oblong, 0.2–0.4 mm long, anther locules parallel. *Female flowers* at least sometimes clustered, 1–2

per cluster; pedicels jointed, at anthesis 2–5.2 mm long, 0.1–0.3 mm wide, in fruit 3–5.8 mm long, 0.3–0.5 mm wide, ± distally dilated, glabrous; sepals 6, 1–2.3 mm long, 0.7–1.7 mm wide, elliptical, circular, to ovate; disk crenate, 1–2.1 mm wide, glabrous, free, at anthesis erect to ascending, in fruit divergent, white or green, with a distinct white margin, rounded to acute, coriaceous, glabrous; styles 3, free, divided for about half their length or less, divergent, white, yellow, to green, 0.4–1 mm long, 0.2–0.4 mm wide, narrow-terete, glabrous, branches entire, linear; ovary 0.3–0.8 mm long, 0.8–1.2 mm wide, transversely ellipsoid and apically depressed, smooth. Fruit a capsule, septicidal, transversely ellipsoid and apically depressed, sometimes with observable venation, 2–2.4 mm long, 2.4–3.8 mm wide, green, cartilaginous, smooth, glabrous, grooved septicidally; column persistent, narrow oblong, 0.9–1.2 mm long. Seeds prismatic, laterally compressed, 1.5–1.9 mm long, 1.2–1.5 mm wide, prominently scalariform to reticulate, occasionally striate yellow-brown to red-brown; hilum slightly depressed, ovate, cavity basal. *Flowering*: June to February. *Fruiting*: July to February.

Distribution and ecology

Phyllanthus striaticaulis is restricted to Kangaroo Island and the Fleurieu and Yorke Peninsulas within South Australia. It has been found in dry sclerophyll forest, grassy woodland and in coastal heaths.

Notes

This species is morphologically very close to *P. australis* Hook. f. Nevertheless, *P. striaticaulis* is easily distinguished from *P. australis* by its strongly ribbed branchlets, white, green or yellowish male flowers, and habit (Table 3). For illustrations of *P. striaticaulis* (as *P. australis*) see Weber (1986). The recognition of *P. striaticaulis* now excludes *P. australis* from South Australia, the latter is confined to Tasmania and Victoria.

The specimen selected as the type is male. This provides maximum utility given the diagnostic features of the new species.

The specific epithet alludes to the noticeable ribbing on the branchlets.

Selected specimens

SOUTH AUSTRALIA: *Tepper s.n.*, Mount Lofty Range, Clarendon xi.1883 (AD); *Ising s.n.*, Waitpinga, Encounter Bay, 16.viii.1957 (AD); *Spooner 6059*, near Arthur Hill, overlooking Tunkalilla Creek, (AD); *Eichler 15481*, near American River at road to Kingscote, (AD); *Spooner 7990*, Lubra Creek about 1 km behind Antechamber Bay, (AD); *Bates 3504*, Port Vincent, ca 35 km North North East of Edithburgh, (AD); *Hall 59*, Cut line road, between Stansbury and Hardwicke Bay, (AD); *Spooner 6130*, Minlaton scrub, (AD); *Brown s.n.*, Yorke Peninsula, 1.xi.1978 (AD); *Blaylock 700*, Hundred of Curramulka, section 141, (AD).

Table 3. Comparison of selected characters for *P. australis* and *P. striaticaulis*. Measurements in mm.

Character	*Phyllanthus australis*	*Phyllanthus striaticaulis*
Habit	weeping	spreading to erect
Branchlets	smooth	ribbed and angled
Laminae	plane	concave
Veins	abaxially not raised	abaxially raised
Male sepal colour	red	white, geen or yellowish
Male pedicel length	1.2–2.5	1.8–6.9
Female pedicel length	1–3	2–5.8
Fruit width	3.7–4	2.4–3.8
Leaf apex	commonly apiculate and turning black	acute and mucronate rarely apiculate or discolourous

Table 4. Occurrence of *Phyllanthus* species in botanical regions of South Australia. +, present; NW, North-western; LE, Lake Eyre; NU, Nullarbor; GT, Gairdner-Torrens; FR, Flinders Ranges; EA, Eastern; EP, Eyre Peninsula; NL, Northern Lofty; MU, Murray; YP, Yorke Peninsula; SL, Southern Lofty; KI, Kangaroo Island; SE, South-eastern. Botanical regions follow Jessop and Toelken (1986).

Species	NW	LE	NU	GT	FR	EA	EP	NL	MU	YP	SL	KI	SE
P. calycinus							+			+	+		
P. erwinii	+												
P. fuernrohrii		+	+	+	+	+	+		+				
P. lacunarius		+							+				
P. lacunellus		+		+	+	+	+		+				
P. maderaspatensis		+			+								
P. oblanceolatus	+				+	+							
P. saxosus				+	+	+	+	+	+		+	+	+
P. striaticaulis										+	+	+	

Key to the South Australian species of *Phyllanthus*

1 Branch leaves reduced to scales (phyllanthoid branching present) .... *P. lacunarius*
1: Branch leaves laminate (phyllanthoid branching absent) 2

2 Female sepals in fruit 3.5–8 mm long and 2.6–7.3 mm wide; fruit 3–5.2 mm long and 5–6.6 mm wide; seeds 2.5–3.9 mm long and 1.8–2.5 mm wide; male pedicels 4.2–9.5 mm long; male sepals 1.2–4 mm long; male disk 0.9–2.5 mm wide .... *P. calycinus*
2: Female sepals in fruit 0.5–3.5 mm long and 0.2–2.6 mm wide; fruit 1.2–3 mm long and 1.9–5 mm wide; seeds 0.9–2.3 mm long and 0.8–1.8 mm wide; male pedicels 0.3–6.9 mm long; male sepals 0.4–2.5 mm long; male disk 0.9–1.7 mm wide 3

3 Plants dioecious 4
3: Plants monoecious 5

4 Branchlets ribbed; stipule apex acuminate to acute; leaves 1.9–4.2 mm wide, margins thickened; anthers 0.2–0.9 mm long; styles 0.4–1 mm long; fruit 2–2.4 mm long, 2.4–3.8 mm wide; seed 1.5–1.9 mm long, scalariform to reticulate .... *P. striaticaulis*
4: Branchlets not ribbed; stipule apex rounded to obtuse; leaves 1.5–16.5 mm wide, margins not thickened; anthers 0.7–1 mm long; styles 1.2–2.4 mm long; fruit 2.6–3 mm long, 4.2–4.7 mm wide; seed 2.1–2.3 mm long, striate .... *P. saxosus*

5 Male pedicels 0.8–5.5 mm long, glabrous to indumented; male sepals 0.7–2.5 mm long; female pedicels at anthesis 0.5–5.2 mm long, in fruit 2.4–8.5 mm long; fruit 1.8–3 mm long; seeds 1.7–2. 5 mm long 6
5: Male pedicels 0.2–1.4 mm long, only ever glabrous; male sepals 0.5–1.7 mm long; female pedicels at anthesis 0.3–1.4 mm long, in fruit 0.8–2.6 mm long; fruit 1.2–2 mm long; seed 1–1.6 mm long 7

6 Hairy shrub; branchlets rounded to ellipsoid; stipules 0.8–3.2 mm long; male sepals 1.3–2.5 mm long; male disk 1–1.4 mm wide; female disk 1.1–1.9 mm long; anther filaments 0.6–1.3 mm long; styles 0.6–1.3 mm long .... *P. fuernrohrii*
6: Herb or small shrub, glabrous; branchlets flattened to ellipsoid; stipules 1.2–2.5 mm long; male sepals 0.7–1.7 mm long; male disk 0.6–1 mm wide; female disk 0.7–1.3 mm wide; anther filaments 0.2–0.6 mm long; styles 0.2–0.7 mm long .... *P. oblanceolatus*

7 Leaves paler abaxially; veins distinctly prominulous abaxially; anther filaments connate; anthers elliptical to circular; styles merely notched; seeds colliculose .... *P. maderaspatensis*
7: Leaves similar on both surfaces; veins not distinctly prominulous; anther filaments free; anthers oblong; styles variously divided; seeds rugose to ribbed 8

8 Branchlets ribbed; lamina apices obcordate to emarginate; leaves papillate; female sepals with a distinct white margin; ovary and fruit verrucate .... *P. lacunellus*
8: Branchlets not ribbed; lamina apices rounded; leaves scabrous; female sepals without a white margin; ovary and fruit smooth .... *P. erwinii*

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ADDITIONAL SPECIES, NEW COMBINATIONS AND OTHER NOTES ON ACANTHACEAE OF AUSTRALIA

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Abstract

A number of new species, both native and naturalised, are newly recorded for Australia. The majority of these, *Ruellia squarrosa* (Fenzl)Cufod., *Hygrophila "Lake McDonald"*, *Barleria cristata* L., *Odontonema tubaeforme* (Bertol.)Kuntze and *Hemigraphis reptans* (Forst.f.)T. Anderson, represent introductions which have subsequently become naturalised. Species previously referred to *Sarojusticia* Bremek. and *Calophanoides* (Clarke)Ridley have been transferred to *Harnieria* Solms-Laub. to give the new combinations *Harnieria hygrophiloides* (F. Muell.)R.M. Barker, *H. kempeana* (F. Muell.)R.M. Barker and *H. kempeana* ssp. *muelleri* (R.M. Barker)R.M. Barker. A possible new species of *Harnieria* is described but left unnamed since the material is inadequate, as is a possible new taxon of *Dipteracanthus*.

There are additional notes on *Ruellia, Asystasia* and *Graptophyllum* as well as *Thunbergia grandiflora* (Roxb. ex Rottler)Roxb., *Brunoniella spiciflora* (F. Muell. ex Benth.)Bremek., *Xerothamnella parvifolia* C.T. White and *X. herbacea* R.M. Barker, *Dicliptera australis* (Nees)R.M. Barker, *Hypoestes aristata* (Vahl)Sol. ex Roemer & Schult. and *H. phyllostachya* Bak. and *Rhaphidospora cavernarum* (F. Muell.)R.M. Barker. New Guinea specimens previously referred to *Rhaphidospora platyphylla* (S. Moore)Bremek. are synonymous with *R. cavernarum* (F. Muell.)R.M. Barker.

Introduction

Since the publication of the revision of Acanthaceae for Australia (Barker 1986), there have been a considerable number of new collections from all states, but particularly Western Australia, Northern Territory and Queensland. Consequently there are a number of changes and additions which need to be made to upgrade the treatment of the family. The order followed here is the same as that found in the revision. Only those species which were poorly known before have been mentioned for extensions of ranges, since all species are now represented by considerably more collections than existed at the time of the revision. New taxa are described without epithets in *Harnieria*, *Hygrophila* and *Dipteracanthus;* these are all based on one or two collections and described here in the hope that more material can be found before they are formally named. In some cases it is not clear whether they represent native or naturalised species.

A cautionary note needs to be sounded here since many of the Acanthaceae cultivated as garden subjects have the ability to become troublesome weeds. *Thunbergia grandiflora* (Roxb. ex Rottler)Roxb., *Thunbergia alata* Boj. ex Sims, *Acanthus cf. mollis* L., *Barleria spp.* and *Ruellia s.lat.* spp. have already been documented but species of *Hypoestes* and *Odontonema* have now to be added to the list of naturalised species with potential to spread.

Thunbergia

Authorship of *Thunbergia grandiflora*

The authorship of this species was somewhat controversial, but in a recent paper Daniel (1991) has cited the authorship as *T. grandiflora* (Roxb. ex Rottler)Roxb. based on *Flemingia grandiflora* Roxb. ex Rottler, in agreement with my original citation.

Ruellia

Generic distinctions between *Ruellia s.str.*, *Dipteracanthus* and *Brunoniella*

As has been already mentioned in the revision (Barker 1986), distinctions between *Dipteracanthus* Nees, *Ruellia s.str.* and *Brunoniella* Bremek. are clear cut when only

Australian taxa are considered. The introduction of cultivated *Ruellia* species of unknown origin into gardens within Australia often erode these differences. Taking into account the introduced species mentioned below, the genera can still be distinguished by the following key.

1 Bracteoles longer than calyx, leaf-like; capsule club-shaped .... *Dipteracanthus*
1: Bracteoles shorter than calyx; capsule flattened cylindrical or club-shaped
  2 Capsules 1–6-seeded, flattened-cylindrical; stigma pubescent .... *Brunoniella*
  2: Capsules more than 10-seeded, flattened cylindrical or club-shaped
    3 Corolla red, throat inflated on one side, lobes short and erect .... *Stephanophysum**
    3: Corolla blue, purple or red, throat symmetrical, lobes spreading .... *Ruellia**

Naturalised *Ruellia* species

The naming of introduced species of *Ruellia* L. used in the horticultural trade is usually extremely difficult since there is no overall account of *Ruellia* s. lat. of the world. Comparison of named species in Australian Botanic Gardens with the descriptions to be found in floras often reveals discrepancies and it is not known whether this is due to different growing conditions or whether the species is wrongly named. Specimens have already been referred to *R.* aff. *malacosperma* since they did not truly agree with either *R. malacosperma* Greenm.or the closely related *R. brittoniana Leonard,* both of which are recognised in their native habitat in the Americas.

Key to introduced *Ruellia* species

1 Flowers red [not recorded as naturalised as yet] .... *R. elegans*
1: Flowers blue or purple
  2 Inflorescence long pedunculate from the axils; seed with mucilaginous hairs all over
    3 Leaves ovate, 1.5–3.5 cm wide; calyx lobes glabrous or with sparse eglandular hairs .... *R. tuberosa*
    3: Leaves narrowly oblong, less than 1.5 cm wide; calyx lobes with glandular hairs .... *R.* aff. *malacosperma*
  2: Inflorescence solitary in the axils; seed with thickened rim of mucilaginous hairs; [plants pilose, some of the lax hairs glandular] .... *R. squarrosa*

Ruellia tuberosa L.

There has been a marked spread of *R. tuberosa* L.in 10 years in the Northern Territory, and there are now records of this species as naturalised in Queensland and Western Australia. It has also been collected as a troublesome garden weed (*Dorney 62*).

Specimens examined

AUSTRALIA: NORTHERN TERRITORY: *R.W. Purdie 3430*, 2.v.1987, Black Jungle area, SE of Darwin (AD, CANB); *R.M. Barker 690*, 12.v.1994, Adelaide River, below Stuart Hwy bridge in parking bay (AD, duplicates to be distributed).

QUEENSLAND: *C.A. Rehbein s.n.*, 13 April 1982, Portion 189, Parish of Leichhardt Downs. From a single plant 18 months ago, it has now spread over two square metres of lawn (BRI); *E.L. Shannon s.n.*, April 1986, Airdmillan Road, Ayr (BRI); *T. Stanley 80174*, 13 Feb 1980, Roadside, near Townsville airport (BRI); *W. Dorney 62*, 29.i.1987, 38 Millchester Rd, Charters Towers (BRI).

WESTERN AUSTRALIA: *A.A.Mitchell 3118*, 26.v.1993, Koolan town site, old unwatered garden (AD, BROOME, PERTH).

Ruellia aff. malacosperma

Ruellia aff. malacosperma is now much more widely recorded in Queensland, including from vine forest (*Godwin s.n.*) and from rainforest (*Thompson 176*).

Specimens examined

AUSTRALIA: QUEENSLAND : *E.R. Anderson 4468*, 21 March 1988, 15 km S of Mt Larcom, Calliope Shire (BRI); *L.H. Bird s.n.*, 20 May 1991, Bundamba Creek, Bundamba, Ipswich (BRI); *Godwin C2467*, August 1983, R774, Parish of Smithfield, bank of Barron River (BRI); *D. Rowland s.n.*, 2 Jan 1992, Gympie City, edge of creek (BRI); *T. Stanley 488*, 18 Feb 1980, North Rockhampton, wasteland adjacent to creek bank and surrounding built-up areas (BRI); *T. Stanley 738*, 20 Feb 1980, Near coal terminal, Gladstone (BRI); *P.K. Thompson 176*, 9 Dec 1989, Reliance Creek, E of Habana (BRI); *F. Waterson s.n.*, 14 Feb 1994, "Stowe Park", Brahman Stud, Calliope Shire (BRI).

Ruellia elegans

Ruellia elegans Poiret, *Encycl. Suppl.* 4: 727 (1816); new name for *R. formosa* Andr.

Ruellia formosa Andr., *Bot.Repos.* 10: tab. 610 (1810) non *Ruellia formosa* Humb. & Bonpl. 1805.

Arrhostoxylon formosum (Andr.)Nees in Martius, *Fl. Bras.* 9: 62 (1847); nom. illeg.

Arrhostoxylon elegans (Poiret)Bremek., *Nederl. Akad. Wetensch., Verh. (Tweede Sect.)* 45(1): 12 (1948).

Type: Illustration in Andrews, *Bot. Repos.* 10: tab. 610 (1810) based on specimen supplied by Donn, Curator of the Botanic Gardens at Cambridge.

Only cultivated specimens have been seen.

Specimens examined

AUSTRALIA: QUEENSLAND: Jindalee, Brisbane, 19.iii.1980, *S.T. Reynolds s.n.* (BRI); Brisbane Botanic Gardens, 28.iii.1977, *H. Caulfield s.n.* (BRI).

Questionable Ruellia sp.

A collection referred to as *Ruellia elegans* (syn. *Ruellia formosa*: see Ezcurra 1993) by the Brisbane herbarium represents a species which has become naturalised on roadsides in Mackay. However the collection is only vegetative and there is no way of knowing whether it is even a *Ruellia*. It is certainly not *R. elegans* since it differs from that species in indumentum and cystolith morphology and is in addition a shrub of 1–2 metres, whereas *R. elegans* is a sparsely branched herb to 50 cm.

Specimens examined

AUSTRALIA: QUEENSLAND: *G.N.Batianoff 9303383, H.A.Dillewaard & I.G.Champion*, 7 March 1993, Slade Point, Teal Strait, Mackay (BRI).

Ruellia squarrosa

Ruellia squarrosa (Fenzl)Cufod. in Walker, *Baileya* 17: 40–42, fig. 1 (1970).

Dipteracanthus squarrosus Fenzl, *Del. Sem. Hort. Bot. Univers. Vindobon. Collect. Anno 1868*: 10 (1869).

Type: "C[ultus in] h[orto] V[indobonensi], 1868, Jul 30. Ex h[orto] Schoenbr[unnensi]." (W) fide Walker (1970), including photograph of type.

Sprawling perennial herb. *Branches* to 60 cm long, densely pilose with erect whitish 3–4-celled eglandular hairs, some of these sometimes with small gland apically. *Leaves* with blade ovate or narrowly ovate, up to 6 cm long, 2 cm wide, attenuate at base, entire, acute apically, younger leaves densely white pilose,sparser with age; petioles to 2 cm long. Inflorescence axillary, solitary. *Bracteoles* linear, 4.5–9 mm long, much shorter than calyx, pubescence as on stems and petioles, but usually glandular. *Pedicel* to 1 mm long on mature

flowers. *Calyx* 10–16 mm long; lobes linear, equal, joined only at very base, pubescence as on bracteoles, persistent but lobes reflexed after fruit is lost . *Corolla* blue, finely pubescent externally on tube and throatand on veins and apex of lobes; tube c. 25 mm long; throat c. 12 mm long, curved slightly; lobes c. 15 mm long, more or less equal. *Stamens* with filaments c. 10 and 14 mm long, pubescent at base, just exserted from throat; anther cells parallel, c. 3 mm long, glabrous; connective extended at apex. *Ovary* glabrous; style minutely hairy, c. 30 mm long; stigma very unequally 2-lobed, longer lobe to 3 mm long, glabrous. *Capsule* 12–15 mm long, glabrous, 16–20-seeded, very shortly stipitate. *Seed* c. 2 mm diameter, thickened rim with mucilaginous hairs, otherwise glabrous.

As yet only known to be naturalised in garden situations but has great potential for spread in waste areas. Flowers ?most of year.

This species has been variously referred to as *Ruellia dipteracanthus* (Nees)Hemsley, *Ruellia squarrosa* (Fenzl)Cufod. and *Ruellia ciliosa* Pursh. It is common in the nursery trade in South Australia, particularly for hanging baskets, and here the name *Ruellia makoyana* hort. Makoy has been used, mainly on the basis of the silvery-white midrib and veins. This last name is obviously incorrect since the original description indicates that flowers of that species are red. *R. ciliosa* Pursh.is a basal rosetted species and so this name would also not apply.

The relationships of this species appear to lie closest to *Dipteracanthus*, except that the bracteoles are not leaf-like and longer than the calyx. Otherwise it possesses the club-shaped capsule and seeds in which the mucilaginous hairs are confined to the thickened rim and the subsessile flowers of that group.

Many thanks to Les Pedley who first collected this species and asked for a name and then ended up drawing my attention to what is hopefully the correct name.

Specimens examined

AUSTRALIA: QUEENSLAND: *L. Pedley 5336*, 3 March 1986, Indooroopilly, naturalised in shady situations in gardens (AD, BRI); *L. Pedley 5307*, 14 Nov 1984, Indooroopilly, Brisbane (BRI).

Another specimen with affinities to *Ruellia squarrosa* but lacking flowers and mature fruits has been collected from the Bamaga region of Cape York Peninsula from the ground cover within mixed semi-deciduous notophyll vine thicket. It is a more robust plant than *Ruellia squarrosa*, but is covered with similar hairs, has similar bracteoles, solitary flowers and immature glabrous capsules. Further collections are required before a name can be applied. Whether or not it is a native, rather than an introduced species, also needs to be established.

Specimen examined

AUSTRALIA: QUEENSLAND: *D.G. Fell 3934, J.P. Stanton & C. Roberts*, 18 Feb 1994, Mt Bremer, western slopes, 26.0 km NE of Bamaga, Injinoo custodial land (BRI).

Stephanophysum

Equivalent name for *Stephanophysum longifolium* Pohl in *Ruellia*

Stephanophysum Pohl is a segregate of *Ruellia* L. and is not always recognised as a distinct genus. In searching for references to members of this genus, particularly in American literature, the appropriate synonym within *Ruellia* needs to be found. In the case of the species *Stephanophysum longifolium* Pohl, this was previously known as *R. graecizans* Backer since the name *Ruellia longifolia* was already preoccupied. It has recently been recognised that *Stephanophysum brevifolium* Pohl, published in the same paper as *Stephanophysum longifolium* Pohl, is conspecific with it and so the epithet "brevifolium" becomes available for use within *Ruellia*. Therefore any reference to

Stephanophysum longifolium Pohl should now also be searched for under *Ruellia brevifolia* (Pohl)Ezcurra as well as *R. graecizans* Backer.

Stephanophysum longifolium Pohl, *Pl. Bras. Icon. Descr.* 2: 85, tab. 156 (1831) n.v.

Ruellia longifolia (Pohl)Griseb. ex Lindau in Engler & Prantl, *Nat. Pflanzenfam.* IV, 3b: 311 (1895); nom.illeg. (predated by *R. longifolia* Rich., *Acta Soc. Hist. Nat. Par.* 1: 110 (1782).; *Ruellia graecizans* Backer, *Brittonia* 3: 85 (1938), "nomen novum for *Stephanophysum longifolium* Pohl".

Type: Brazil, without specific locality, *Pohl s.n.*; syn: W (fide Ezcurra 1993).

Ruellia brevifolia (Pohl)Ezcurra, *Darwiniana* 29: 278 (1989).

Stephanophysum brevifolium Pohl, *Pl. Bras. Icon. Descr.* 2: 84, t. 155 (1831).

Type: Rio de Janeiro, Brazil, s.dat., *Schott s.n.*; holo: W n.v. (fide Ezcurra 1993)

Echinacanthus dichotomus O. Kuntze, *Rev. Gen. Pl.* 489 (1891); Lindau in Engler & Prantl, *Nat.Pflanzenfam.* IV, 3b(1895)302.

Type: Buitenzorg, May 1875, *O. Kuntze 4389*; NY: n.v. (fide Ezcurra 1993).

Illustration: Ezcurra, C. (1993). Ruellia in Southern South America. *Ann. Missouri Bot. Gard.* 80: 803, fig. 7. (as *Ruellia brevifolia*).

Previously only recorded as naturalised near Nambour (Barker 1986).

Specimens examined

AUSTRALIA: extra specimens from QUEENSLAND: Foot Sanctuary, Buderim, 17.iii.1992, *I.P. Joyce-Smith s.n.* (BRI); Mulgrave River, c. 10 km upstream from Gordonvale, 30.iii.1992, *J.P. Stanton s.n.* (BRI).

Dipteracanthus

A single collection of what appears to be a new species of *Dipteracanthus* is described below, in the hope that more material become available. It is possible that it represents another subspecies of *D. australasicus* F. Muell. rather than a distinct species. It has the same questionably glandular hairs as those found on *D. australasicus* ssp. *dalyensis* R.M. Barker.

1 Stamens and style included in corolla throat; flowers more or less sessile; corolla blue, mauve, purple or white, opening during the day; tube less than 10 mm long before widening into throat; capsule glabrous.

2 Branches and petioles with covering of short dense, suberect eglandular hairs obscuring cystoliths .... *Dipteracanthus "Kalpowar" (Fell 2969)*

2: Branches and petioles glabrous or with lax eglandular hairs not obscuring cystoliths .... *D. australasicus*

1: Stamens and style exserted from corolla throat; flowers long-pedunculate; corolla white, cream or pale yellow, opening at night; tube 20–26 mm long before widening into throat; capsule with fine hairs at least in upper half. .... *D. bracteatus*

Dipteracanthus "Kalpowar" (Fell 2969)

Spreading erect herb to 30 cm; roots ?not tuberous. *Branches* more or less square in cross-section cystoliths not visible due to covering of short dense, suberect eglandular hairs, usually with longer, sparser, lax , 3–8-celled eglandular hairs ending in an elliptic swelling or gland. *Leaves* petiolate, blade broadly ovate, up to 5 cm long and 3.5 cm wide, rounded at base, crenulate, broadly acute at apex, sparsely pubescent with age with same pubescence as on stems extending onto young leaves, petioles, midribs, main veins and margins; cystoliths linear, obvious only on upper surface in dried specimens; petiole up to 12 mm long. *Inflorescence* triad in each axil, outer flowers of triad developing after central flower; flowers more or less sessile. *Bracteoles* shortly petiolate, obovate, c. 11 mm long including petiole, 4–5 mm wide, densely ciliate with long lax hairs which extend onto darker abaxial

surface, inserted almost immediately below calyx of two lateral flowers, not persisting in fruit. *Calyx* with truncate, slightly ridged base, c. 5 mm long; lobes linear, shortly ciliate. *Corolla* purple/mauve, ?1.5–2 cm long, moderately pubescent on throat and lobes with 2–3-celled lax eglandular hairs externally, shape unknown but probably as in *D. australasicus*; tube cylindrical, erect, glabrous externally, constricted apically at point of insertion of 4 stamens; lobes c. 4 mm long. *Stamens* included, inserted at top of tube where it bends into throat, filaments c. 4 mm long; anthers c. 2 mm long, with connective extended apically. *Disc* annular, with single extension. *Ovary* glabrous, with 4 overlapping ovules per cell; style c. 7 mm long, pubescent; stigma ?just exserted or ?included in throat of corolla; stigma with single broad lobe c. 1.5 mm long. *Capsule* glabrous, 6–8 seeds subtended by prominent hooks usually developing near middle of capsule. *Seed* c. 4 mm diameter, appearing glabrous when dry, thickened rim rapidly expanding on wetting to reveal hairs; flattened sides of seeds glabrous.

Spreading erect herb to 30 cm, roots ?not tuberous. Branches more or less square in cross-section.

Deciduous vine thicket with canopy of *Brachychiton australis* and *Gyrocarpus americanus* on uniform red brown coarse sandy loam derived from Dalrymple sandstone. Flowers and fruits present on March specimen.

Specimen examined

AUSTRALIA: QUEENSLAND: *D.G. Fell 2969 & J.P. Stanton*, 28.iii.1993, Bathurst Range, Kalpowar Pastoral Holding, 68.5 km N of Lakefield H.S. (AD, BRI).

Range extension for *D. australasicus* ssp. *dalyensis*

Dipteracanthus australasicus ssp. *dalyensis* R.M. Barker, previously only known from the Daly River Rd area in the Northern Territory, was extended in its range by a collection from the Fitzmaurice River area in 1994.

Specimen examined

AUSTRALIA: NORTHERN TERRITORY: *G.J. Leach 4272 & N.G. Walsh*, 9.v.1994, Bupa, 4 km S of Jarrong Yards (AD, DNA, MEL).

Brunoniella

Brunoniella spiciflora more common than previously thought

There have been a considerable number of collections of *B. spiciflora* (F. Muell. ex Benth.)Bremek. since the revision and it would appear that this species is not as threatened as was previously thought. The species has been recollected in all of the areas listed in the revision as well as from Upper Tallebudgera, south of Brisbane. *B. spiciflora* (F. Muell. ex Benth.)Bremek. was initially confused by Brisbane botanists with *Isoglossa eranthemoides* (F. Muell.)R.M. Barker from which non-flowering material can be distinguished by its 4–10 smooth, pubescent seeds and by the very unequal size of leaves in each leaf pair (anisophylly) compared with 1–4 ornamented, glabrous seeds and more or less isophyllous leaves of *I. eranthemoides* (F. Muell.)R.M. Barker.

Flower colour is noted as white on the one specimen which possessed flowers (*P.R. Sharpe 4825, E. Ross & L. Tan*), but the majority of collections were made in February and March when only fruits were present. All collections were from along watercourses in complex notophyll vineforest or closed rainforest or from sides of tracks.

Selected specimens examined

AUSTRALIA: QUEENSLAND: *P.Bostock s.n.*, 17.xii.1990, Upper Tallebudgera Creek, Gorge Falls area, 14 km SW pf Tallebudgera Village (BRI); *W.J.McDonald 4452a, D.G.Fell & J.P.Stanton*, 26.xi.1989, Southern side of

Broken River picnic area, Eungella N.P. (BRI); *P.R.Sharpe 4788*, 9.iii.1989, East Cedar Creek, Blackall Range, c. 8 km NNW of Mapleton (BRI); *P.Young 741 & J.Elsol*, 29.ii.1984, Boombana N.P., Mt Nebo, Brisbane Forest Park (BRI).

Brunoniella linearifolia

B. linearifolia R.M. Barker, along with a number of the *Brunoniella* species was recorded as questionably tuberous. A collection by Glen Wightman (*Wightman 3107*) removes any doubt about the tuberous nature of this species, since each individual plant has at least 8, and up to 14, tuberous roots at their base.

Specimen examined

AUSTRALIA: NORTHERN TERRITORY: *G.Wightman 3107*, 10.x.1986, Arnhem Hwy, 20 km W of West Alligator River (AD, CANB, DNA).

Hemigraphis

Extension of range for *H. royenii*

Collections of *Hemigraphis royenii* Bremek. have now been made from the McIlwraith Range. Previously it had only been recorded from the Iron Range. Two of the collections were from complex mesophyll vineforest, while the other was from grassland on a floodplain. All were fruiting, suggesting flowering occurs at the end of the wet season, which is at odds with the proposed flowering suggested in Barker 1986.

Specimens examined

AUSTRALIA: QUEENSLAND: *P.I.Forster 10511 & G.Sankowsky*, 13.vi.1992, Nesbit River (BRI); *P.I.Forster 10603, M.C.Tucker & G.Sankowsky*, 16.vi.1992, Rocky River Scrub, Silver Plains Stn (BRI); *P.I.Forster 10616, M.C.Tucker & G.Kenning*, 16.vi.1992, Rocky River Scrub, Silver Plains Stn, eastern fall of McIlwraith Range (BRI);

Introduced species becoming naturalised?

Hemigraphis reptans (Forst.f.)T. Anderson is a variable species often cultivated or found as a weed in tropical houses or nurseries. A recent collection from Palmerston, a suburb or Darwin, Northern Territory, almost certainly represents this species and comments on the collection indicate that it is here regarded as a weed. It can be distinguished from the native species, which is confined to the Iron and McIlwraith Ranges area of Queensland (see above), by its scarcely overlapping bracts in the inflorescence, these bracts also being distinctly petiolate at least in the lower part of the inflorescence. *H. reptans* often has the lower surface of the young leaves and bracts purplish in colour.

Specimen examined:

AUSTRALIA: NORTHERN TERRITORY: *I.D.Cowie 5187*, 1 Feb. 1995, 18 Widdup Cres., Palmerston (AD, DNA).

Hygrophila

A collection from Lake McDonald near Cooroy in Queensland by A.R. Bean (*Bean 6770*) represents a third species of *Hygrophila* R. Br. for Australia. It differs from *H. angustifolia* R. Br. and *H.* cf. *triflora* (Roxb.)Fosberg & Sachet by the lack of any hairs on the palate, the more divided calyx (fruits are not enclosed for most of their length in the fused calyx as in *H. angustifolia* and the smaller size of the flowers. Cystoliths are usually very visible in dried specimens of *H. angustifolia* but this is not the case for this material. It is possibly an introduced American species, *H. guianensis* Nees ex Benth., but authentic material has yet to be seen.

Replacement Key

1 Lower lip of corolla lacking any hairs and possibly without barred palate; calyx c. 6 mm long [Lake McDonald near Cooroy, Qld] .... *Hygrophila "Lake McDonald"* (Bean 6770)

1: Lower lip of corolla with long hairs on barred palate; calyx more than 8 mm long.

  2 Plants not submerged, at edge of wet areas; leaves narrow-linear to lanceolate with entire or undulate margins, glabrous or with appressed eglandular hairs [northern Australia] .... *H. angustifolia*

  2: Plants often growing submerged; submerged leaves pinnatifid and glabrous, emergent leaves ovate, serrate and covered with erect glandular hairs [Once recorded from Berry Springs near Darwin; popular fish tank species] .... *H. triflora*

Hygrophila "Lake McDonald" (Bean 6770)

Herb to 90 cm. Stems quadrangular, longitudinally grooved, glabrous or moderately to densely pubescent with simple multicellular eglandular hairs. *Leaves* subsessile, narrowly elliptic, up to 9 cm long and 2 cm wide, subentire, acuminate, subglabrous or sparsely appressed pubescent above and below, particularly on meidrib and veins. *Inflorescence* comprising axillary whorls of 10 or more flowers. *Bracteoles* shorter than calyx. *Calyx* 5-lobed, 5.5–6 mm long; sepals joined below half way, shortly pubescent on margins and midrib. *Flowers* white, 2-lipped, shortly appressed eglandular pubescent externally; tube 3.5 mm long; upper lip 2.5 mm long, 2-lobed, porrect; lower lip 3 mm long, 3-lobed, with longitudinal folds on lower lip but lacking any hairs and, from dried material, apparently lacking any barred coloration. *Stamens* didynamous, each long and short filament joined by basal pubescent membrane, free filaments glabrous, 1.5 mm long and 0.5 mm long respectively; anthers 0.8 mm long. *Ovary* glabrous; style simple, glabrous; stigma very unequally 2-lobed. *Capsule* narrowly ellipsoid, 6–8 mm long, c. 20-seeded, seeds more numerous at base; retinacula present.

Recorded from swampy mergins of lake, with *Persicaria.* Flowering October, fruiting inflorescences present February.

The two specimens known both came from Lake McDonald, one in October 1993 and the second in February 1994. Despite the fact that the accompanying labels indicate that they came from different districts and from different latitudes and longitudes, it is assumed that both came from the same locality i.e. Lake McDonald near Cooroy. The first collector of the species, A.R. Bean, obviously recognised the difference of this species from *H. angustifolia* R. Br. and presumably asked for additional material. The second collection is much less pubescent than the first and the leaves somewhat wider, but otherwise the two agree.

Specimens examined

AUSTRALIA: QUEENSLAND: *A.R. Bean 6770*, 10.x.1993, Lake McDonald, 4 km NE of Cooroy (AD, BRI, NSW); *K. Garraty s.n.*, 23.ii.1994, Lake McDonald Dam (BRI).

Barleria

B. cristata L. and *B. prionitis* L. naturalised in Queensland

A key has been provided to the four commonly cultivated species but only descriptions of *B. prionitis* L. and *B. lupulina* Lindley were included since they were the only ones naturalised at that time; they were only recorded from the Northern Territory. *B. cristata* L. and *B. prionitis* L. have now both been recorded as naturalised in Queensland, and a description of the former is included below.

Barleria cristata L., *Sp. Pl.* 636 (1753).
Type citation: "India". Syntypes: *Anon. s.n.*, s.dat., India (LINN 805.10, 805.11, 805.12, seen on microfiche in AD).

Shrubs. *Branches* obscurely 4-angled, glabrous, without spines. *Leaves* with blade elliptic to obovate, 4–9 cm long, up to 3 cm wide, entire, acuminate, sparingly appressed pubescent, denser on midrib and veins, dark green without red midrib; petiole to 15 mm long. *Inflorescence* 1–3 flowers per axil. *Bracts* and *bracteoles* linear, c. 1 cm long, spine-tipped, green throughout, entire or toothed, shortly pubescent, lacking glands. *Sepals* white, pale or hyaline with darker coloured reticulate veins; longer pair ovate, c. 20–25 mm long, somewhat unequal, thinly glandular and eglandular hairy on exposed parts, spine-tipped apically and on marginal teeth (prolongation of veins); shorter pair linear, not toothed, c. 9 mm long,. *Corolla* blue or violet, rarely white, 4–6 cm long . *Capsules* and seeds not seen on Australian material.

Garden escape, with potential to spread further by its ability to sucker easily. Flowers ?year round.

Specimens examined

AUSTRALIA: QUEENSLAND: *J.R. Clarkson 6405*, 8.iv.1986, Thursday Island, by old gun emplacement on Green Hill (AD, BRI, MBA, QRS); *B.M. Waterhouse 1177*, 29.viii.1990, Portland Roads, village area immediately adjacent to Weymouth Bay (BRI).

Barleria prionitis

Specimen examined

AUSTRALIA: QUEENSLAND: *W.J. Dorney 342*, 7.xii.1993, Ross River, Townsville (BRI).

Odontonema, a new generic record for Australia

A plant usually known as *Odontonema strictum* (Nees)Kuntze, commonly grown in gardens in Australia, has the capacity to spread into natural bushland. Amongst specimens received on loan from BRI was a single specimen of *Odontonema* from the edge of the Noosa National Park, southeast Queensland. This genus belongs in subtribe Odontoneminae along with *Pseuderanthemum, Graptophyllum* and *Asystasia.* The species has tubular red flowers, 2–3 cm long, in dense narrow racemes extending well above the leaves.

Odontonema

Odontonema Nees, *Linnaea* 16: 300 (1842) nom. cons.

Type species: *Odontonema rubrum* (Vahl)Kuntze (*Justicia rubra* Vahl), typ. cons.

Erect shrubs with linear cystoliths. *Leaves* petiolate, opposite pair connected by transverse ridge. Inflorescence terminal, raceme-like, flowers in clusters. *Bracts* 2, small; bracteoles 2, similar to bracts. *Calyx* small, with 5 segments, free almost to base, more or less equal. *Corolla* red, scarcely 2-lipped, long tubular; lobes 5, short, more or less equal. *Stamens* 2, inserted near middle of corolla tube, included (in Australia); anthers 2-celled, cells parallel, inserted equally; staminodes 2. *Ovary* with 2 ovules per cell; style long; stigma capitate. *Capsule* (not formed in Australia) clavate, basal part lacking seeds; seed-bearing hooks prominent. *Seed* 2 or 4, flat, glabrous.

An American shrub genus of c. 30 species occurring from Mexico to Brazil; a few species are cultivated as ornamentals.

Many of the species of *Odontonema* exhibit distyly with thrum stamens exserted and thrum style included and pin stamens included and pin style exserted. Red-flowered species of the *O. callistachyum* complex, to which the Australian introduction belongs, are thought to be humming-bird pollinated (Daniel 1995).

Within Australia this genus should be easily recognised since it is one of only three in which the flowers are red. *Graptophyllum* is easily distinguished by its woody habit and

distinctly 2-lipped flowers with exserted stamens, while *Stephanophysum* has 4 stamens. In neither genus is the inflorescence raised above the rest of the plant as it is in *Odontonema.*

Odontonema tubaeforme (Bertol.)Kuntze, *Rev. Gen. Pl.* 2: 494(1891).

Justicia tubaeformis Bertol., *Novi Comment. Acad. Sci. Inst. Bononiensis* 4: 405 (1840) n.v.

Type: Guatemala, Escuintla, 1836, *Velasquez s.n.*; holotype: BOLO (n.v., fide Daniel 1995).

Odontonema strictum (Nees)Kuntze, *Rev. Gen. Pl.* 2: 494(1891).

Thyrsacanthus strictus Nees, A. DC., *Prodr.* 11: 324 (1847).

Type citation: "Honduras, *Armstrong*" (Hooker herb., K, n.v.).

Odontonema callistachyum sensu Fosberg, Sachet & Oliver, *Fl. Micronesica* 5: 34.

Herb 1–2 m tall; branches quadrangular, often longitudinally grooved, subglabrous. *Leaves* elliptic, up to 18 cm long and 8 cm wide, entire or crenulate, long acuminate with the tip sometimes curved to one side, glabrous above and below except for puberulence along the midrib and veins below. *Inflorescence* terminal, raised above rest of plant, consisting of many (opposite or whorled) sessile dichasia in the upper half of rachis up to 30 mm long; rachis shortly and evenly erect, eglandular pubescent. *Calyx* c. 2 mm long, lobes c. 1 mm long, glabrous. *Corolla* red, glabrous, 2–3 cm long, consisting of 15–18 mm long tube, widening into a narrow, 1-sided, 9–10 mm long throat; lobes 4–5 mm long, ciliate at apex. *Stamens* included. *Ovary* ?glabrous; style 14–17 mm long, glabrous; stigma. *Fruits* not formed.

There is much confusion concerning the correct name for this species. Australian material conforms with Fosberg, Sachet & Oliver's (1993) description of *Odontonema callistachyum* (Schltdl. & Cham.)Kuntze in *Flora Micronesica.* Fosberg *et al.* sank the widely cultivated *Odontonema strictum* (Nees)Kuntze into synonymy under *O. callistachyum* since they could perceive no difference between these species. However, in recent papers on Acanthaceae of Panama (Daniel & McDade (1995)) and a revision of *Odontonema* in Mexico (Daniel 1995), *O. callistachyum* is considered to be to be a distinct species with pinkish-purple flowers restricted to Mexico, Brazil and Guatemala. Based on their key, our material appears to identify most closely with *O. tubaeforme* (Bertol.)Kuntze, which includes *O. strictum* (Nees)Kuntze as a synonym..

Specimen examined

AUSTRALIA: QUEENSLAND: *P.R. Sharpe 4302 & G.Batianoff,* 20 March 1986, Noosa National Park, Noosa, c. 300 m SW of Park Rangers Headquarters (BRI).

Asystasia

Asystasia gangetica (L.)T. Anders.

Asystasia gangetica (L.)T.Anderson is commonly cultivated in tropical Australia. Previous records from Kununurra and diverse locations in northern Queensland were known to be garden escapes but it was unclear whether the species had become naturalised. Collections from Port Douglas from a vacant block were clearly naturalised as was a recent collection from about an old settlement on Groote Eylandt.

Specimen examined

AUSTRALIA: QUEENSLAND: *W.R. Barker 5578,* 21.vii.1988, Port Douglas, vacant block 200–300 m back from beach (AD).

NORTHERN TERRITORY: *B.M. Waterhouse 3170,* 10.v.1994, Bartalumba Bay, Groote Eylandt (AD, DNA).

Asystasia "Newcastle Bay" (Brass 18671)

The unnamed *Asystasia* species, represented by a single Brass collection from Newcastle Bay (*Brass 18671*), has also been collected from the Mount Molloy area. This collection varies somewhat from the Brass collection in hair covering and flower size, since it is covered in all parts only with lax eglandular hairs and the flowers have the tube and throat 13.5 mm long (cf. 8–10 mm), and the free filaments of the stamens 5 and 7.5 mm long (cf. 3 and 4.5 mm). Flowers are recorded as "white or very pale pink with dark pink spotting" and the collection was made from the "margin of a deciduous vine thicket on steep boulder strewn slope", a locality rather different from the coastal sand dunes of the Brass collection.

Specimen examined

AUSTRALIA: QUEENSLAND: *J.R. Clarkson 7910 & R.J.F. Henderson*, 18.iv.1989, Font Hills, c. 15 km W of Mt Molloy (AD, BRI, K, L, MBA, QRS).

Xerothamnella

A disjunct location of *Xerothamnella parvifolia*

Xerothamnella parvifolia C.T. White, previously known only from southern central Queensland and north-western New South Wales has now been collected on several occasions from the Flinders Ranges, South Australia. These collections represent a disjunction of some 3–400 km between Mt Poole in NSW and Big Moro Gorge in SA and indicate a once much wider distribution for the species. The status and management of the South Australian populations of this species are discussed in Davies (1995).

Specimens examined

AUSTRALIA: SOUTH AUSTRALIA: *R. Bates 22955*, 15.iv.1990, 5 km E of Big Moro Gorge (AD).

Extra collections of *X. herbacea*

There are two further collections of *X. herbacea* R.M. Barker within the collections of the Brisbane herbarium. The recent Forster collection (*Forster 9860)* was found some distance from the type locality of Chinchilla while the older collection *(Johnson 2689B)* was from further north in the Theodore area. Both collections are from heavy soils in brigalow (*Acacia harpophylla*), as was the type collection.

Specimens examined

AUSTRALIA: QUEENSLAND: *P.I. Forster 9860*, 7.v.1992, Burraburri Creek, 16 km W of Durong (BRI, MEL); *R.W. Johnson 2689B*, 27.ix.1963, Site of Brigalow Research Station, 20 miles NW of Theodore (BRI).

Dicliptera

First collection of *Dicliptera australis* (Nees)R.M. Barker since 1818.

Dicliptera australis (Nees)R.M. Barker was recollected by A.A. Munir in 1988. Until then it had been thought to quite possibly be extinct since there were no collections known other than those made by Allan Cunningham in 1818 from Goulborn Island. The species was relocated on the mainland near Goulborn Islands. Since it differs from the rest of *Dicliptera* in possessing non exserted stamens, Nees described it as a distinct genus.

Corollas in the specimens have a combined tube and throat length of 10mm and lobes of 3–4 mm. There appear to be no markings or striations. Capsules are as for *D. arnhemica*, with only a covering of glandular hairs at the apex, and the seeds are smooth, glabrous and 2.5 mm long. *D. australis* and *D. arnhemica*, which are unique in *Dicliptera* by sharing the characteristic of equally inserted anther cells, can be distinguished from each other not only by the inserted and exserted stamens but also by the lack of striations on the corolla lobes in

D. australis and their much shorter length (3–4 mm compared to 10–17 mm long in *D. arnhemica*).

Specimen examined

AUSTRALIA: NORTHERN TERRITORY: *A.A. Munir 6172*, 6.vi.1988, 38 km SE of Murgenella at the junction of the road leading to Wunya Beach towards Aurari Bay (AD 2 sheets, duplicates in BRI, CANB, DNA, NSW, PERTH).

Hypoestes

Authorship of introduced and commonly cultivated *Hypoestes aristata*

The introduced and commonly cultivated species of *Hypoestes* is often wrongly called *H. antennifera* S.Moore. The correct name and synonymy is given below. It has the potential to become a serious environmental weed; naturalised plants have already been recorded in Queensland and New South Wales and specimens have been seen in South Australia.

Hypoestes aristata (Vahl)Sol. ex Roemer & Schult., *Syst. Veg.* 1: 140 (1817).

Justicia aristata Vahl, *Symb. Bot.* 2: 2(1794) see Balkwill & Norris, *S. Afr. J. Bot.* 51: 133–144 (1985). Basionym.

H. antennifera S. Moore, *J. Bot.* 18:41 (1880).

This species, now also used within the cut flower trade, is easily grown from cuttings and produces copious fruits with fertile seed. It can be distinguished from the native species, *H. floribunda* R. Br., by its dense axillary clusters of flowers and the long "aristate" apices of the outer involucral bracts. These bracts are only fused for about 1 mm at the base and the long apices, which are not truly aristate since they are not stiff, are covered with glandular hairs.

Specimens examined

AUSTRALIA: NEW SOUTH WALES: *R.G. Coveny 16243*, 5.viii.1992, Darling Mills Creek off Mahers Rd, West Pennant Hills in Cumberland SF extension (AD, BRI, CBG, K, MEL, MO, NSW, PRE).

QUEENSLAND: *L. Pedley 5373*, 3.v.1987, St Lucia, Brisbane (BISH, BRI, LAE, NSW).

"Freckle Face" Hypoestes

The plant commonly cultivated under the name "Freckle face", "Pink-Dot" or "Baby's-Tears" with white or pink spots on the green leaves, is a species of *Hypoestes*, probably *H. phyllostachya* Bak.. It is recorded as a garden escape in Queensland and has also been noted as established in a lawn on G.T.Short's property at Curramulka in South Australia.

Specimen examined

AUSTRALIA: QUEENSLAND: *A.R. Bean 5366*, 1.i.1993, 15.2 km along Silver Valley Rd, SW of Herberton (BRI).

Graptophyllum

A new species of *Graptophyllum*, *G. reticulatum* Bean & Sharpe, has been described from Queensland (Bean & Sharpe 1991). This species has the large toothed leaves of *G. ilicifolium* (F. Muell.)F. Muell. ex Benth., but unlike that species with its large red flowers, *G. reticulatum* has small white flowers as in *G. spinigerum* F. Muell. In the same paper, Bean & Sharpe also reduced *G. thorogoodii* C.T. White to *G. excelsum* (F. Muell.)Druce. Without a better understanding and a comprehensive analysis of the leaf and flower variation of all of the species of *Graptophyllum* in Queensland this was possibly premature. Most of the comments concerning the taxonomy of the genus in 1986 are still relevant although there has been no evidence to support the suggestion of different flower sizes on

the one plant. There still remains difficulty in placing much of the sterile material, and even some collections with flowers (e.g. *McDonald 5684* from Shoalwater Bay has the same size leaves as *G. ilicifolium* (F. Muell)F. Muell. ex Benth. but lacks the spiny margins of that species), and the doubts expressed concerning the present species status persist.

G. spinigerum has now been recorded from the Northern Territory.

Specimen examined

AUSTRALIA: NORTHERN TERRITORY: *J. Russel-Smith 3913 & C.R. Dunlop*, 1.xi.1987, Devil Devil Pass, N Central Arnhem Land (AD, BRI, CANB, DNA, MEL, NSW, QRS).

Justicia s.lat.

Since the revision, Graham (1988) has published her results of a survey of some of the morphological characters of *Justicia* sens.lat. She advocates a broad approach which I am still reluctant to adopt for the same reasons given in the revision; the chief objection remains the lack of characters to distinguish the genus from related genera and the variable interpretation of the genus throughout the world. It is now regarded by some authors merely as a holding genus (e.g. Henrickson & Hiriart 1988, Wasshaussen 1992) highlighting the need for detailed analytical work within the group. The genera recognised in Australia correspond to sections delimited by Graham.

Name change for *Sarojusticia* and *Calophanoides*

As already discussed in in my previous paper (Barker 1986), *Sarojusticia* Bremek. and *Calophanoides* (Clarke)Ridley need to be combined. This was not done in that paper since I was unsure about the status and validity of the predominantly African genus *Calophanoides.* Graham (1988) treated both *Calophanoides* and *Sarojusticia* as part of Sect. Harnieria of *Justicia.* A revision of the tropical African species of that group has also been published by Hedren (1989). New combinations and a new species are published below, while a new subspecies of *Harnieria kempeana* from the Cape Range is published in this same journal by Lepschi.

Harnieria

Harnieria Solms-Laub., *Sitzb. Ges. Naturf. Fr. Berlin, 1864*: 1 (1864) *n.v.*

Justicia sect. *Harnieria* (Solms-Laub.)Benth. in Benth. & Hook.f., *Gen. Pl.* 2: 1109 (1876).

Type: Harnieria dimorphocarpa Solms.-Laub.

Justicia sect. *Calophanoides* Clarke in Hook.f, *Fl. Brit. India* 4: 530 (1885).

Calophanoides (Clarke)Ridley, Fl. Malays. Pen. 2: 592 (1923).

Type: *Justicia quadrifaria* (Nees)T. Anders. (fide Graham 1988).

Sarojusticia Bremek., *Acta Bot. Neerl.* 11:195 (1962).

Type: *Sarojusticia kempeana* (F. Muell.)Bremek. ex H. Eichler.

Harnieria hygrophiloides (F. Mueller)R.M. Barker *comb. nov.*

BASIONYM*: Justicia hygrophiloides* F. Mueller, *Fragm. Phyt. Austral.* 6: 89(1867).

Calophanoides hygrophiloides (F. Mueller)R.M. Barker. For typification see Barker 1986.

There is a single specimen, retained from the original BRI loan, which may represent either another species of *Harnieria* for Australia or it may be part of the variation of *H. hygrophyloides;* there is insufficient material to determine this. A brief description is included here in the hope that further collections might clarify its status.

Harnieria "Mt Garnet"(Myers s.n.)

Sprawling shrub, branchlets c. 20 cm long, 4–6-angled and longitudinally furrowed, densely covered with short suberect white eglandular hairs, sparser with age. *Leaves* with petioles 1.5–2 mm long; blade elliptic, 7–11 × 3.7–6 mm, subentire, rounded obtuse or shallowly emarginate apically, densely pubescent with similar hairs to those on stem, becoming sparser with age and confined to petiole midribs and margins; cystoliths dot-like. *Inflorescence* of sessile, solitary flowers in the axils of each leaf i.e. 2 per node. *Bracts* obovate, of similar length to calyx, c. 4.5 mm long, 1.7 mm wide, rounded obtuse or possibly shallowly emarginate apically. *Bracteoles* obscure. *Calyx* segments c. 4.5 mm long, 0.4 mm wide, moderately densely pubescent with similar hairs to branches; cystoliths not visible. *Corolla* colour unknown but probably white with purple markings, externally pubescent, c. 8 mm long overall. Upper anther cell c. 0.7 mm long, sparsely hairy on back; lower anther cell basally spurred. *Ovary* moderately densely pubescent apically, hairs extending on to base of style. *Capsule* not seen.

Found on yellow chocolate soil in savannah woodland. Flowering December.

This collection differs from *H. hygrophiloides* by its externally pubescent corolla, solitary flowers, smaller leaves and bracts and the apparently non emarginate bracts. More collections are required before the taxon can be formally described.

Specimen examined

AUSTRALIA: QUEENSLAND: *R.J. Myers s.n.*, 19 Dec. 1960, Queensland, St Ronan's Station, Mt Garnet (BRI).

Harnieria kempeana (F. Mueller)R.M. Barker, *comb. nov.*

BASIONYM. *Justicia kempeana* F. Muell., *Fragm. Phyt. Austral.* 11: 101 (1880)p.p. (excluding Giles collections belonging to *Dicladanthera* and *Dipteracanthus*).

Sarojusticia kempeana (F. Muell)Bremek. ex H. Eichler, *Suppl. Black's Fl. S. Austral.* 284 (1965). *Typification* see Barker 1986

Harnieria kempeana ssp. ***muelleri*** (R.M. Barker)R.M. Barker, comb. nov.

BASIONYM. *Sarojusticia kempeana* ssp. *muelleri* R.M. Barker, *J. Adelaide Bot. Gard.* 9: 243 (1986).

Note that a new subspecies, *Harnieria kempeana* ssp. *rhadinophylla* has been described from the Cape Range in Western Australia by B. Lepschi in a separate paper within this journal.

Rhaphidospora

***Rhaphidospora cavernarum* (F. Muell.)R.M. Barker recollected and identified with a later named New Guinea species**

Included with a loan of specimens of Acanthaceae from BRI were a number which had been misidentified as *Asystasia australasica* F.M. Bailey. These specimens agreed with material from New Guinea (LAE) which had been identified as *Rhaphidospora platyphylla* (S.Moore)Bremek. and it was originally my intention to publish them as such. However it seemed likely on closer examination that the specimens, although much more robust, were conspecific with *Rhaphidospora cavernarum*(F. Muell.)R.M. Barker, of which only fragments had been seen for the revision. They have been treated as such here, and the later names, *Justicia platyphylla* S. Moore and *Rhaphidospora platyphylla* (invalid, since the basionym was not referred to by Bremekamp when he made the combination in 1957) have

been reduced to synonymy. An expanded description is included here since the original description in the revision (Barker 1986) had many unknown states.

Rhaphidospora cavernarum (F. Muell.)R.M. Barker, *J. Adelaide Bot. Gard.* 9: 232 (1986) see there for synonymy and typification.

Justicia platyphylla S. Moore, *J. Bot.* 58: 193 (1920).

Rhaphidospora platyphylla (S.Moore)Bremek., *Nova Guinea* n.s. 8: 151 (1957) nom. invalid. (basionym not cited).

Types: *C.T. White 270*, Astrolabe Range, New Guinea (BRI, ?BM, n.v.); *C.T. White 546*, Dilava (BRI, ?BM n.v.).

Perennial, tuberous herb, 30–100 cm high; branchlets longitudinally striate, constricted above nodes, glabrous apart from a line of sparse white recurved eglandular hairs, not spinescent. *Leaves* ostensibly with petioles 0.5–2 cm long, but the blade frequently continuing thinly to node on at least one side; blade ovate, 3–12 cm long, 1.5–6.5 cm wide, smaller leaves rounded at base, older apparently attenuate, crenate, rounded acute apically, glabrous apart from sparse recurved white hairs along margin, darker above than below. *Inflorescence* a 15–30 mm long terminal di- and trichotomously branched panicle with much shorter, less branched panicles also arising from the axils below; peduncles with mixed short, erect, simple, colourless eglandular hairs overtopped by less frequent, longer and wider, simple glandular hairs, dense when young but progressively sparser with age. *Bracts* and bracteoles c. 1 mm long, with similar indumentum to peduncle, glabrescent. *Pedicel* c. 1 mm long. *Calyx* segments 2–3 mm long, similar indumentum to peduncle. *Corolla* white with purple palate on lower lip, externally covered with moderately dense, simple, white eglandular hairs; tube 5–6 mm long; upper lip 2.7–3.5 mm long, notched, possibly with glabrous style channel; lower lip with median lobe c. 4 mm long, lateral lobes c. 5.5 mm long. *Stamens* with glabrous filaments, c. 2.5 mm long; anther cells 0.7 mm long, pubescent on back of apical cell, appendage on lower cell 0.4–0.5 mm long. *Ovary* glabrous; style eglandular pubescent at base, glabrous distally. *Capsule* 12 mm long, lower half constricted into narrow stalk, widened above into seed-bearing portion c. 3 mm wide, covered all over with simple white, eglandular hairs. *Seed* pale brown, dark brown with age, covered all over with 0.2–0.3 mm long, obscurely barbed, spines.

Often locally common and dominant in the ground cover in deciduous vine thicket or notophyll vine forest, but also found in rocky areas or river beds. Flowering March to July.

There are minor differences in the pubescence of the rachis of the inflorescence, that of the Australian material having a dense covering consisting of longer glandular hairs above a glandular puberulence, while the New Guinea material tends to only have occasional longer glandular hairs if any, and the puberulence is less dense. Leaves of the Australian material are crenate, while those of the New Guinea sheets are entire. Without a better range of material it is not justifiable to separate these.

New Guinea notes record the species from "poor primary lowland rainforest" (*Schodde 2810*) and as a "ground cover near stream bank" (*Womersley NGF12364*).

Reference was made in Barker (1986), under *R. cavernarum,* to the need for a study to be made of the *R. glabra* (or *Justicia glabra* Koenig) complex of tropical Africa and India, since *R. cavernarum* could be conspecific with it. Moore (1920) also commented without specific detail, on differences between *J. glabra* (of India) and *J. platyphylla* in foliage and corolla; he considered that *J. platyphylla* resembled a Philippine plant distributed as "*Justicia glabra* Koen. var." in foliage although the "flowers are quite different".

Sankowsky notes on his collection (*Sankowsky 999*) that this species possesses large tubers deep underground, and Fell (*Fell 3254*) notes that the leaves are browsed by wild cattle.

Specimens examined

AUSTRALIA: QUEENSLAND: COOK DISTRICT: *D.G. Fell 2965B & J.P. Stanton,* 26 March 1993, Bathurst Range, Kalpowar Pastoral Holding, 68.5 km N of Lakefield HS (BRI, DNA, MEL, CANB, MBA); *D.G. Fell 3209 & J.P. Stanton,* 8 May 1993, Cape Melville N.P., Altanmoui Range Section, 1.6 km E of Flat Hill, 62.6 km NE of Lakefield HS (BRI, CANB); *D.G. Fell 3509 & R. Jensen, 21 August 1993,* Mount White, 3 km SSW of Coen, Lochinvar Holding, Cape York Peninsula (BRI); *D.G. Fell 3254 & J.P. Stanton,* 9 May 1993, Upper Howick River, 48.9 km ENE of Lakefield HS, Kalpowar Pastoral Holding, (BRI); *PD.G. Fell 3434, R. Jensen & G. Barnes,* 17 Aug 1993, Round Mountain, Embley Range, 8.5 km WSW of the Nesbit River mouth, 54.1 km NE of Coen (BRI, MEL); *P. Forster 10057, M.C. Tucker & G. Kenning,* 3 June 1992, 27 km along road to Leo Creek Mine, McIlwraith Range (BRI, QRS); *P. Forster 10482 & Tucker,* 13 June 1992, Round Mountain, Embley Range (AD, duplicated in BRI, K, L, MEL, QRS). *P. Forster 10404 & Tucker,* 12 June 1992, Chester River Scrub, eastern fall of McIlweaith Range, Silver Plains Station (BRI, QRS); *P. Forster 15392 & Tucker,* 29 June 1994, Hill 334, Pascoe River (BRI, QRS); *P.I. Forster 13599, G. Sankowsky & M.C. Tucker,* 14 July 1993, 8 km past Pascoe River Crossing on road to Portland Roads (BRI, QRS); *P.I. Forster 13528, G. Sankowsky & M.C. Tucker,* 10 July 1993, Pascoe River Crossing, road to Iron Range (BRI, DNA, QRS); *G. Sankowsky 999, N. Sankowsky, P. & A. Radke,* 25 June 1989, Archer River (BRI).

PAPUA NEW GUINEA: *R. Schodde 2810,* 17.viii.1962, near Rigo, Central District, Papua (LAE, duplicates not listed); *J. Womersley NGF12364,* 1.ix.1967, 2 miles inland from Kapa Kapa, Rigo subdistrict, Papua (LAE 2 sheets, duplicated in BRI, L).

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A NEW SUBSPECIES OF *HARNIERIA KEMPEANA* (ACANTHACEAE) FROM WESTERN AUSTRALIA

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Abstract

Harnieria kempeana (F. Muell.)R.M. Barker subsp. *rhadinophylla* Lepschi, a taxon endemic to North West Cape, Western Australia, is described and illustrated. A key to the subspecific taxa of *Harnieria kempeana* is provided.

Introduction

Harnieria kempeana (F. Muell.)R.M. Barker [syn. *Sarojusticia kempeana* (F. Muell.)Bremek. ex Hj. Eichler] has been considered to have a disjunct range in the eremean regions of central and western Australia. Two subspecies have previously been recognised: subsp. *kempeana* in the Alice Springs area of the Northern Territory, and subsp. *muelleri* (R.M. Barker)R.M. Barker in the Murchison and Gascoyne regions of Western Australia (Barker 1986). A third subspecies, endemic to the Cape Range area south-south-west of Exmouth, Western Australia, has only recently been recognised as a new taxon within *H. kempeana*, and is here described as new.

There is disagreement as to generic limits within the tribe Justicinae, of which *Harnieria* Solms-Laub. is a member; these are discussed by Barker (this volume), whose concepts are followed here.

Taxonomy

Harnieria kempeana (F. Muell.)R.M. Barker, J. Adelaide Bot. Gard. 17 (1996) 150.

Sarojusticia kempeana (F. Muell.)Bremek. ex H. Eichler, Suppl. Black's Fl. S. Austral. (1965) 284. For additional synonymy and notes on nomenclature see Barker (1986, 1996).

For descriptions, notes and illustrations of *H. kempeana* subsp. *kempeana* and subsp. *muelleri* (as *Sarojusticia*) see Barker (1986).

Key to subspecies of *Harnieria kempeana*

1 Leaves and leaf-like bracts narrowly to very-narrowly oblong or ± linear (less often narrowly to linear-obovate or elliptic, very rarely obovate), lamina (2.8-) 6–20 times longer than broad; margin always entire. Exmouth area, Western Australia .... subsp. *rhadinophylla*

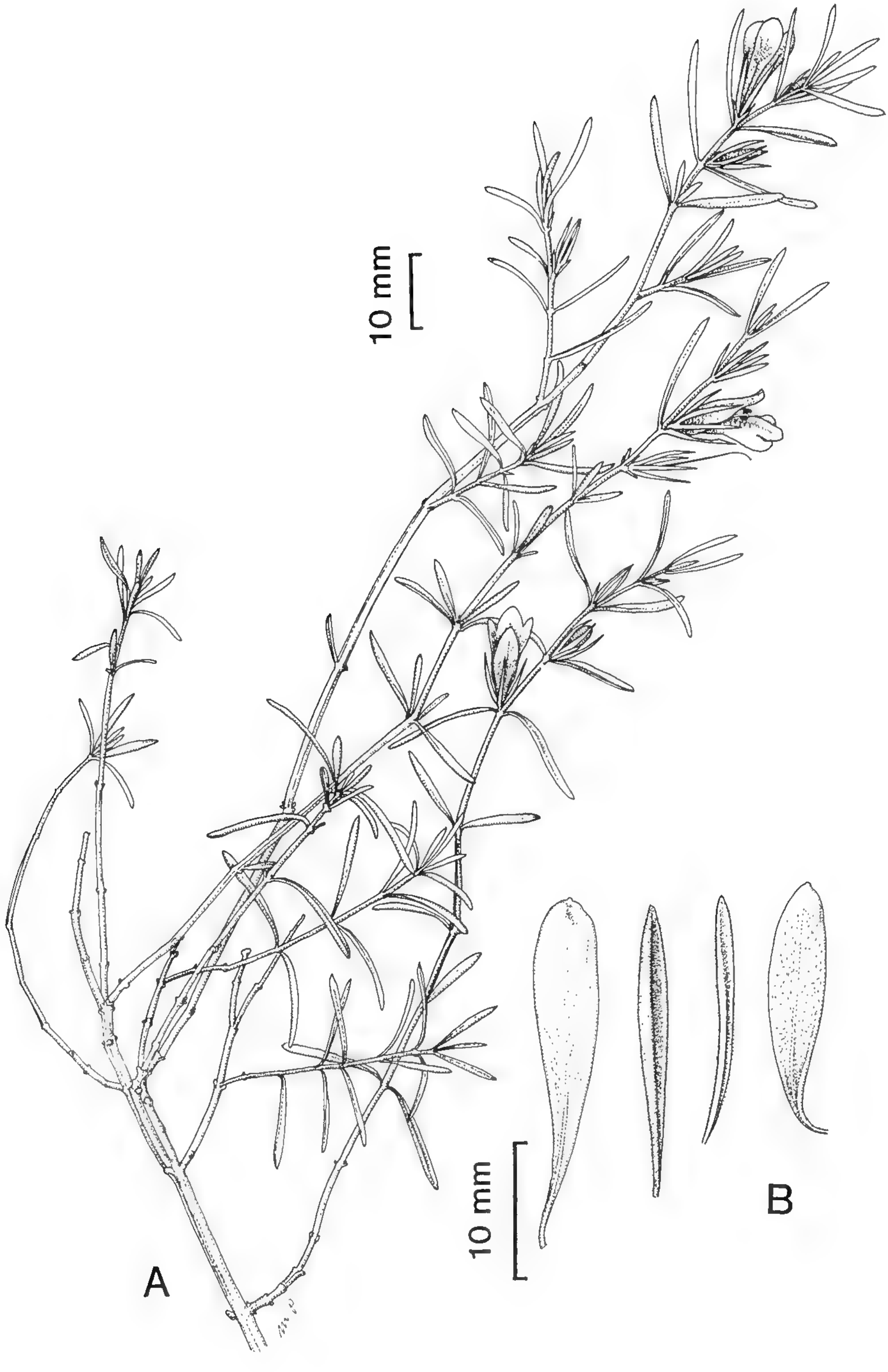
1: Leaves and leaf-like bracts orbicular to ovate, or elliptic to obovate or narrowly obovate, lamina 1.2–4.3 times longer than broad; margin entire, irregularly crenate or 2–5 toothed 2

2 Leaves and leaf-like bracts distinctly 2–3 (-5) toothed along one side, orbicular to ovate. Stigma distinctly capitate. Hairs on stems straight, spreading. Alice Springs area, Northern Territory .... subsp. *kempeana*

2: Leaves and leaf-like bracts entire to irregularly crenate, orbicular to elliptic or obovate to narrowly obovate. Stigma subcapitate. Hairs on stems usually retrorse to recurved, generally appressed. Eremean Western Australia .... subsp. *muelleri*

Harnieria kempeana (F. Muell.)R.M. Barker subsp. **rhadinophylla** Lepschi, *subsp. nov.*

A subsp. *muelleri* lamina anguste ad angustissime oblonga aut aliquantum lineari, interdum anguste ad angustissime lineare-obovata aut lineare-elliptica, longitudine (2.8-) 6–20 plo longiora quam latae, margine semper integro differt.


10 mm
10 mm
A
B

Type: North West Cape, c. 10 km south of the centre of Exmouth, 24.vii.1995, *M.E. Trudgen 12864* (holo: PERTH 04177878; iso: AD, CANB, K, L).

Erect or sprawling, spreading, straggly shrub to c. 1 m; vegetative parts, calyx, corolla and capsule densely hairy with short, spreading, whitish eglandular hairs ("conical bristles" of Barker 1986). *Leaves* and leaf-like bracts subsessile or petiole to 1.5 mm long; lamina narrowly to very-narrowly oblong or ± linear, less often narrowly to linear-obovate or elliptic, very rarely obovate, 6–33 × 1–4.6 mm, (2.8–) 6–20 times longer than broad; base attenuate, apex obtuse to acute, margin entire, hairy. *Inflorescence* of solitary, subsessile flowers in axils of leaf-like bracts. *Bracteoles* similar in form, subsessile or petiole to 0.5 mm long, lamina (1.5–) 2–2.7 × 0.4–0.6 (–0.8) mm, hairy. *Calyx* 6.5–9 mm long, hairy. *Corolla* 12–14.5 mm long, deep pink to intense magenta with white palate, hairy externally. *Staminal filaments* free for 5.0–5.5 mm, proximally hairy, white; upper anther cell 1.0–1.3 mm long, lower anther cell 1.2–1.3 mm long, basal appendage 0.4–0.5 mm long. *Ovary* glabrous, sparsely hairy distally; style 6.0–9.0 mm long with scattered hairs in the proximal portion, stigma subcapitate. *Capsule* (7–) 8–10 mm long, glabrescent. *Seeds* ± ovate, flattened, verrucose, pale brown, turning dark brown upon maturity. Fig. 1.

Specimens examined (all cited)

WESTERN AUSTRALIA: *A.S. George 1311*, Cape Range, N of Charles Knife road, 30.viii.1960 (CANB, PERTH 2 sheets); *A.S. George 6547*, W of No. 2 oil well site, Cape Range, 23.v.1965 (PERTH); *L. Sweedman 3435*, Off Yardie Creek road, 19.ix.1994 (KPBG); *T. Tapper 64*, Cape Range National Park, Pilgramunup Gorge, 1.viii.1987 (PERTH).

Distribution: Currently known only from the Cape Range, Western Australia, south-south-west of Exmouth. Map 1.

Ecology

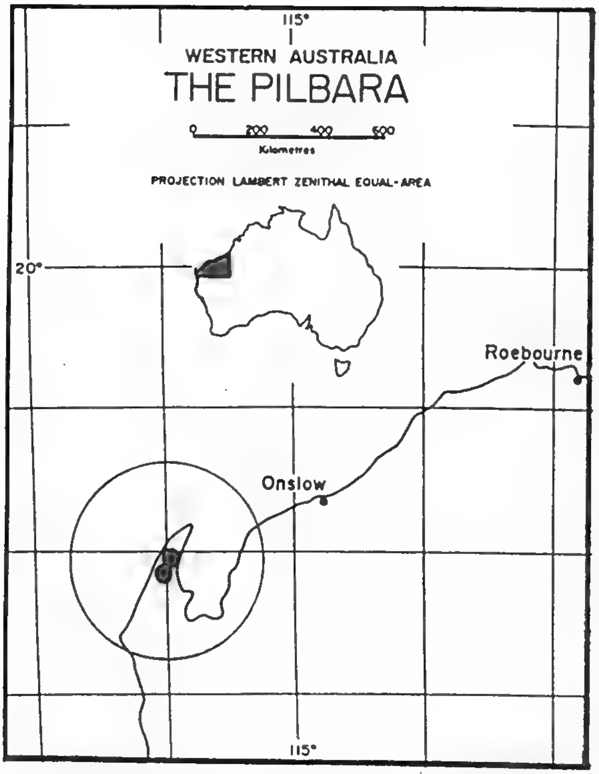
Detailed ecological data is scant, but the new taxon is apparently restricted to areas of limestone, where it occurs along creeks and gorges (rocky watercourses are also the preferred habitat of the other subspecies of *H. kempeana* (see Barker 1986)). At the type locality, the habitat was described as the edge of a small floodplain next to a creek running between limestone ridges, with the substrate as a humus layer over rich, brown calcareous loam with some calcareous pebbles. Vegetation at the type locality was *Eucalyptus* cf. *hamersleyana* mallee low open forest to low closed forest over *Acacia alexandri, A. pyrifolia* (spindly form), *Senna artemisioides* subsp. *oligophylla* (Cape Range form) high open shrubland over *Olearia* sp. shrubland, with a variety of grasses, herbs and shrubs as minor components. Label data on *Sweedman 3435* records *Grevillea, Ipomoea* and *Acanthocarpus* as associated vegetation.

Phenology: Flowering and fruiting recorded May to September.

Notes

Variation in *Harnieria kempeana* appears to be clinal (supporting Barker's suggestion (pers. comm.) that the disjunct populations are relicts of a once wider distribution), with leaves becoming shorter and broader, and also with a greater degree of incision and lobing of the leaf margin, from west to east within the species range. Subsp. *rhadinophylla* is the western extreme of this variation, possessing very narrow leaves with consistently entire margins. The indumentum of subsp. *rhadinophylla* (i.e. short, spreading, whitish eglandular

Fig. 1. ***Harnieria kempeana*** (F. Muell.)R.M. Barker subsp. ***rhadinophylla*** Lepschi. A, flowering branchlet; B, leaves (broader leaves are from the lower nodes of the branchlet of one portion of this collection). (A, *Trudgen 12864*; B, *George 1311*).



Map 1. Distribution of ***Harnieria kempeana*** subsp. ***rhadinophylla***.

hairs) is similar to that of subsp. *kempeana*, although some collections of subsp. *muelleri* also have an indumentum of (or approaching) this type (e.g. *Blackall 224, De Jong 43481-7, Wilcox 99* (pro parte), all PERTH). The subcapitate stigma of subsp. *rhadinophylla* is a character also shared by subsp. *muelleri.*

Conservation status

*CALM Conservation Codes for Western Australia Flora: Priority 2. Although restricted in range, at least two populations are conserved within the Cape Range National Park; oil drilling activities on the North West Cape may be a possible threat to some populations. The type population consisted of approximately 15 plants, with another similar sized population c. 700 metres upstream.

Etymology: From the Greek, *rhadinos* (slender), and *phyllon* (leaf), in reference to the narrow leaves of this subspecies in comparison to the other subspecies.

Acknowledgements

I am grateful to Malcolm Trudgen for bringing this taxon to my attention, gathering material for the type collection, and for his comments on the manuscript. Robyn Barker kindly made available unpublished information from her research on the Australian Acanthaceae, and commented on the manuscript. Margaret Pieroni prepared the illustration and Paul Wilson assisted with the Latin diagnosis.

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* For definitions of the conservation codes currently being used by the Western Australian Department of Conservation and Land Management see Anon. (1996).

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SOLANUM SARRACHOIDES SENDTN. – A NEW ALIEN *SOLANUM* IN AUSTRALIA

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Abstract

Solanum sarrachoides Sendtn. is newly recorded as an alien for Australia. A description, and notes on its distribution, ecology and distinction from related species are provided.

Introduction

Solanum sarrachoides Sendtn. and *S. physalifolium* Rusby var. *nitidibaccatum* (Bitter)Edmonds are a closely related pair of short-lived, weedy herbs belonging to the taxonomically complex section *Solanum* (black nightshades). Both species are indigenous in southern south America, but are also widespread as weeds in temperate regions of the northern hemisphere (nominate var. *physalifolium* is relatively rare, and is restricted to northern Argentina and Bolivia and does not occur as an adventive or naturalised plant elsewhere (Edmonds 1986)).

The two taxa, in common with most members of section *Solanum*, have tortuous nomenclatural histories, and have variously been regarded as conspecific (Dandy 1958, Stanley & Ross 1986, Symon 1981), as distinct taxa (Henderson 1974, Morton 1976) or simply confused (Hawkes & Edmonds 1972, Schilling & Heiser 1979). Edmonds (1986) in a very detailed study, showed that the two taxa are indeed distinct at the species level and unravelled the complex nomenclature of the entities involved.

To date, only *S. physalifolium* var. *nitidibaccatum* has been recorded from Australia, as a sporadic weed in all states (including the Australian Capital Territory) except the Northern Territory (Symon 1981). The name *S. nitibaccatum* Bitter (= *S. physalifolium* Rusby var. *nitidibaccatum* (Bitter)Edmonds) has generally been applied to Australian material of this taxon (e.g. Beadle *et al.* 1981, Curtis 1967, Everist 1974, Henderson 1974, Stanley & Ross 1986, Willis 1972), but *S. sarrachoides* Sendtn. has also been used, but less frequently (Haegi & Symon 1986, Purdie *et al.* 1981, Symon 1981). More recently, following publication of Edmonds' work, the correct name *S. physalifolium* Rusby var. *nitidibaccatum* (Bitter)Edmonds has been applied (e.g. Conn 1992).

Recently material of *S. sarrachoides* was received at CANB; the purpose of this note is to draw attention to the presence of this new alien and to prevent any further occurrences being overlooked due to confusion with the superficially similar *S. physalifolium* var. *nitidibaccatum*.

Solanum sarrachoides Sendtner in Martius, *Flora Brasiliensis*, 10 (1846) 18 pro parte (emend. Bitter, *Feddes Rep.* 11 (1912) 208.

Lectotype: Brazil, *Sellow s.n.* (P), *n.v.* (*fide* Edmonds, *Bot. J. Linn. Soc.* 92 (1986) 16–23.

Synonyms: for complete synonymy see Edmonds (1986).

More or less bushy, annual or rarely short-lived perennial herb to 60 cm (described as to c. 1 m in Australian material), covered with simple, viscid, glandular hairs to 2 mm long

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and sessile gland. *Leaves* (32-) 39–76 (-112) × (27-) 31–51 (-80) mm, ovate; base truncate to rounded, attenuate to the petiole, apex acute, margins regularly sinuate-dentate with 3–9 antrorse lobes; solitary and alternate or geminate (slightly unequal); petioles 16–32 (-38) mm. *Inflorescence* a simple umbellate cyme, 3–4 (-5) flowered. *Peduncle* usually leaf opposed, rarely internodal, 3–13 mm long in flower, 4–16 (-28) mm long in fruit, infructescence rhachis 0–2 mm. *Pedicels* 7–11 mm. *Calyx* 3–6 mm long in flower; lobes oblong-triangular slightly acuminate at apex, (2-) 3–5 mm × 1 (-2) mm in flower; in fruit lobes narrowly triangular, 5.5–8 × 3.5–4 mm. *Corolla* broadly stellate to pentagonal, white with yellow/translucent basal star, 5–7.5 mm diameter, lobes broadly triangular, 3–4.5 (-7 in Australian material) mm × 5–7 mm. *Filaments* 1–1.5 mm. *Anthers* yellowish, (1.5-) 2 mm long. *Style* 3–3.5 mm long, occasionally exserted beyond anthers, stigma capitate. *Berry* globular, pale green, shiny becoming dull, opaque (no information on fruits in the fresh state for Australian material), falling with pedicels still attached, 6–9 mm diameter, usually completely enveloped by enlarged calyces; calyces become papery and strongly reflexed at full maturity, exposing the berry. *Seeds* 1.3–1.5 × 1–1.3 mm, pale yellowish, flattened, (23-) 59× 69 (-93) per fruit. *Sclerotic granules* 4–6, c. 1–1.3 mm broad.

The above description is based on that in Edmonds (1986), with due reference to the Australian material. For illustations and photographs of both *S. sarrachoides* and *S. physalifolium* (both varieties) see Edmonds (1986). Illustrations of *S. physalifolium* var. *nitidibaccatum* are also included in Conn (1992), Haegi & Symon (1981), Henderson (1974) and Symon (1981). Soborino Vesperinas & del Monte Díaz de Guerñeu (1994) review the identificaiton and occurrence of *S. sarrachoides* and *S. physalifolium* var. *nitidibaccatum* in Spain, and provice additonal characters for separating the two species.

Indigenous to central and southern South America; distributed as a weed in North America (casual) and western Europe (Edmonds 1986). Known in Australia only from Montague Island (15°13'Lat. 36°15'Long.), c. 9 km ESE of Narooma, N.S.W.

Specimen examined

NEW SOUTH WALES: *Heyligers 89025*, 4.iv.1989, *Heyligers 92011*, 29.iii.1992, Montague Island (CANB (2 sheets), NSW).

Notes

Heyligers 89025 was collected growing in beach sand c. 2 m above the high tide line at the base of a steep rocky gully which bisects the island, with little other vegetation apart from some chenopods, and *Heyligers 92011* from the same site, on rock ledges immediately above the beach (for information on the vegetation of Montague Island see Heyligers & Adams (1989)). No information is available as to the relative abundance of *S. sarrachoides* at this locality, although it appears that only a few plants are present. The current (1995) status of this population is unknown, as the site was not visited on subsequent trips to the island (the most recent in November 1994; Heyligers pers. comm.).

How this species arrived at Montague Island is unknown; Edmonds (1986) states both *S. sarrachoides* and *S. physalifolium* var. *nitidibaccatum* as adventives in the northern hemisphere are often associated with "South American trade", as both taxa may occur as contaminants of grain and other commodities. Neither species is regarded as a serious weed, and certainly *S. physalifolium* var. *nitidibaccatum* has not been at all successful in Australia, when compared with related taxa such as *S. nigrum* L. or *S. chenopodioides* Lam.

Examination of collections held at AD, BRI, CBG (now incorporated in CANB), HO, MEL, NSW & PERTH revealed no additional collections of naturalised *S. sarrachoides* from Australia.

As mentioned above, *S. sarrachoides* is most likely to be confused with *S. physalifolium* var. *nitidibaccatum*, but can be distinguished by the following key, which may be inserted into the key in Purdie *et al.* (1981):

p. 77 rewrite lead 24 as follows:

24 Plants erect or sprawling, mature berry green

25 Indumentum of glandular hairs; fruiting calyx lobes 2–8 mm long, 2–4 mm wide; berry 5–9 mm diameter

25a Inflorescence a 4–10 flowered racemose cyme; axis in fruit 2–12 mm long; calyx in flower 2–3 mm long, flowering calyx lobes 1–2 mm long, 0.5–1 mm wide; fruiting calyx lobes broadly triangular, 2.5–4 mm long; seeds 15–24 per berry, 1.8–2.4 mm long, 1.3–1.9 mm wide ....*S. physalifolium* var. *nitidibaccatum* (as "*S. sarrachoides*" in Purdie *et al.* 1981)

25a: Inflorescence a 3–4 flowered umbellate cyme; axis in fruit 0–2 mm long; calyx in flower 3–6 mm long, flowering calyx lobes 3–5 mm long, 1–2 mm wide; fruiting calyx lobes narrowly triangular, 5.5–8 mm long; seeds 59–69 per berry, 1.3–1.5 mm long, 1–1.3 mm wide................*S. sarrachoides*

25: Indumentum predominantly of non-glandular hairs; fruiting calyx lobes 1–2.5 mm long, 1–2 mm wide; berry 8–10 mm diameter..*S. opacum*

Acknowledgements

I am grateful to Petrus Heyligers for providing me with additional information on his collection, and to Alex Buchanan, Paul Forster, David Symon, Neville Walsh and Peter Weston for examining collections on my behalf in AD, BRI, HO, MEL and NSW respectively. Lyn Craven and David Symon commented on the manuscript.

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NEW TAXA, NEW COMBINATIONS, KEYS AND COMMENTS ON GENERIC CONCEPTS OF *ZYGOPHYLLUM* AND A NEW SPECIES OF *TRIBULUS* (ZYGOPHYLLACEAE) IN THE MANUSCRIPTS OF THE LATE HJ. EICHLER

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Abstract

Manuscript notes made by Hj. Eichler indicated a new species of *Zygophyllum*, *Z. flavum*, in the *Z. ammophilum* complex and 3 new species, *Z. tetrapterum*, *Z. cuneatum* and *Z. verticillatum* in the *Z. aurantiacum* complex. All are formalised here, but *Z. cuneatum* and *Z. verticillatum* have been treated as subspecies i.e. *Z. aurantiacum* ssp. *cuneatum* and . *Z. aurantiacum* ssp.*verticillatum*. Keys to both complexes had been drafted by Eichler.

Background

From the early 1960's, when he was based at the Herbarium of South Australia (AD), until his sudden death in 1992, Dr. Hansjoerg Eichler of the Australian National Herbarium (CANB) worked on Zygophyllaceae. He produced five papers (Eichler 1963, 1984, 1986, 1990, 1992) on the family and in his retirement was actively working on an account for the *Flora of Australia* with some funding from Australian Biological Resources Survey (ABRS).

The author was contracted to produce a *Flora of Australia* treatment of the family Zygophyllaceae during 1995. As part of this work Eichler's manuscripts and specimens were consulted. From these it became quite clear that he had recognised a number of new species for many years and these species were known not only through annotations on specimens in herbaria by Eichler but also by other botanists who identified *Zygophyllaceae*, for example W.R. Barker in AD and R. Cranfield and M. Lawrence in PERTH. Within the manuscripts left by Eichler there were no formal descriptions of any of these species, although there were notes on the morphology of individual specimens under a number of species made both by Eichler and by Alison Rowell who worked with him under ABRS funding in Canberra. Rowell had also plotted distributions of characters and collections in some of the complexes e.g. an analysis of the leaf lengths of *Z. aurantiacum* and *Z. verticillatum*.

Within *Tribulus,* Lawrence (1992) indicated that she had been told by Eichler that the name *T. platypterus* Benth. had been misapplied to specimens with prominent corky outgrowths on the stems. Within his manuscripts, Eichler consistently used the name *T. suberosus* for this species and had obviously communicated this name to Lawrence since all PERTH specimens received on loan were annotated with this name by her. Specimens in MEL were also annotated by Eichler with this name.

Within ZYGLIT, a computer data-base maintained by Eichler on the literature of Zygophyllaceae in Australia, begun in October 1990 and with the last printout dated April 1992, he indicated his intention to publish *T. suberosus, Z. cuneatum, Z. flavum, Z. kalgoorliense, Z. lobulatum, Z. tetrapterum* and *Z. verticillatum* in 199*. All of these names are published below, with the exception of *Z. kalgoorliense.* Unlike the other species, for this name there are few clues as to its identity apart from the name. It is listed in another data-base of names and types, ZYGAUS, but again, unlike the other species cited, there is

no type mentioned. There are no specimens annotated with this name but it may relate to a very small-flowered, possibly annual, form of *Z. eremaeum* from the Kalgoorlie area.

The descriptions which appear below for all of the new taxa have been compiled by me from specimens predominantly annotated by Eichler. In the case of *Zygophyllum*, the format is similar to that used by Eichler when he described four new species for inclusion in the *Flora of New South Wales* (Eichler 1990). The types all conform with those selected and listed by Eichler in ZYGAUS, the database of names and types (Nomenclator) for Australian Zygophyllaceae maintained by Eichler. Although the species concepts are Eichler's, authorship of the new taxa, by Article 46.3 of the *International Code of Botanical Nomenclature* (Greuter et al., 1994), should be cited as "H. Eichler ex R.M. Barker" since he did not supply the descriptions or diagnoses. Authorship of the new combination *Z. lobulatum*, on the other hand, should be cited as "H. Eichler in R.M. Barker" since no description or diagnosis was required.

It seems a pity that the distinctive 'Hj.', always used on his collections and also initially used by Hansjoerg when describing new species and making new combinations (see for examples Eichler 1965) has been replaced by the more sterile and less informative 'H.' in the "Authors of Plant Names" (Kew *Draft Index* culminating in Brummitt & Powell 1992). However Hansjoerg himself conformed with this in his later publications and it is used here.

ZYGOPHYLLUM

Generic Concept

A draft key found within the Eichler manuscripts indicates that he was considering recognising three genera within *Zygophyllum* s.lat. of Australia.

On the basis of the floral parts in threes, the heteromerous flowers and the amplexicaul two lobed leaves, *Z. howittii* was recognised as a distinct genus and *Roepera* was resurrected to cover the 4-winged fruited species with non appendaged filaments i.e. the *Z. aurantiacum* complex. *Zygophyllum* was confined to those species with 4- or 5-angled fruits.

No justification for these genera has been found, apart from the key, and because of time limitations and the desire not to burden the taxonomic literature with more, possibly superfluous names, the forthcoming treatment being prepared for *Flora of Australia* will treat all species as *Zygophyllum*. A cladistic analysis of the group is a long term aim, but this will require an in-depth investigation of the fruit morphology of the group.

The *Z. aurantiacum* complex

Within this group Eichler recognised three new species and there are many specimens annotated with his manuscript names. Two of them are formalised here as subspecies of *Zygophyllum aurantiacum* even though within his manuscripts *Z. verticillatum* was treated at specific level. One of the new species, *Z. tetrapterum*, is not included in the key. It is distinct from all but *Z. eremaeum* by the petals being of similar length to the sepals; from *Z. eremaeum* it can be distinguished by the wide net venation on the fruit and by the dissociation of the fruit into 4 winged nutlets.

Unlike the other three taxa, the manuscript name "*Z. reticulatum*" which occurs in the key, does not appear on any of the specimens annotated by Eichler. It is likely from the description of the fruit that it is the taxon annotated by him on some occasions as "Zygophyllum sp. (aff. Z. fruticulosum DC.)"; the characteristic separating this taxon is the wide net venation found on the fruit, hence the term "reticulatum". This character is shared by the fruits of *Z. fruticulosum* and *Z. tetrapterum*. The name has not been formalised here because the taxonomy of this group has still to be finalised and it appears to encompass a number of taxa.

Key to *Z. aurantiacum* complex (winged fruited species)

It should be emphasised that this was only a draft key and as such, not all information was given in opposing leads. Measurements in square brackets were missing from the key and have been supplied by the author. *Z. tetrapterum* was not included but the characters used to distinguish it are discussed above. A further taxon, sometimes referred to as *Z. "simplicifolium"* was not included in the key or within the manuscripts but I have seen occasional specimens inscribed with this name. Note that in the original of this draft key *Roepera* was used as the generic name.

1 Flowers small; petals oblanceolate to narrow-elliptical, [3–4.2 (-5.5)] mm long, acute at apex, scarcely exceeding the sepals. Fruits indehiscent, 8–10 mm long, 1-seeded; wings very thin, papery, with numerous parallel veins .... *Z. eremaeum* (Diels)Ostenf.

1: Flowers larger; petals obovate, rounded at apex, distinctly exceeding the sepals. Capsule larger, sometimes dividing septicidally into 4 nutlets.

2 Leaves sessile i.e. subterete leaflets in whorls of 4 inserted seemingly directly on the branches .... *Z. aurantiacum* ssp. *verticillatum* H. Eichler ex R.M. Barker

2: Leaves distinctly petiolate.

3 Leaflets oblong or linear, not distinctly articulate at base and almost as broad as the petiole. Flowers large. Petals [5.5–11] × [3–5.7] mm.

4 Veins on wings of fruits many and almost parallel. Leaflets usually forming a narrow angle with each other i.e. V-shaped

5 Leaflets narrow-oblong to linear, about as long as the linear petiole. Slender shrubs, usually straggling on other plants. Fruit [8.7–16] × [10–19] mm, usually splitting into 4 one- or two-seeded nutlets .... *Z. aurantiacum* ssp. *aurantiacum* (Lindl.)F. Muell.

5: Leaflets broad, shorter than to almost as long as the cuneate petiole into which they are confluent. Stronger semiglobular, independent subshrubs. Fruit [15–20] × [14–15.5] mm .... *Z. aurantiacum* ssp. *cuneatum* H. Eichler ex R.M. Barker

4: Veins on wings of fruit forming a wide-meshed net and not conspicuously densely parallel. Leaflets spreading almost at right angles to petiole (leaf T-shaped) .... *Z. "reticulatum"* H. Eichler MS

3: Leaflets lanceolate (slightly falcate) to narrow elliptical, distinctly articulate at base. Wings of fruits with wide net venation. Fruit [11–25] × 11–30] mm. [Petals 5.2–7 × 2.4–3.2 mm] .... *Z. fruticulosum* DC.

Zygophyllum aurantiacum ssp. **cuneatum** H. Eichler ex R.M. Barker, *ssp. nov.*

Subspecies nova *Z. aurantiaco* ssp. *aurantico* proxima sed differt foliis petiolo longo obovato cuneato et foliolis minoribus.

Holotypus: *R. Schodde* s.n., 23 Aug.1956, Stockyards, Head Station, Koonamore, South Australia (AD96430231).

Spreading, glabrous, woody perennial shrub, 20–50 (-100) cm high, wider than high. *Leaves* apparently simple, consisting of obovate or obtriangular petiole, bi- or more rarely, tri-lobed at apex; leaflets very short, ?succulent, broadly to transversely ovate, 1–6 mm long, 2–4 mm wide, continuous with petiole, rounded obtuse at the apex; petiole 13.5–18.5 mm long, 6.5–13 mm wide (at widest point), flattened.

Confined to South Australia where it has been recorded from the Lake Eyre, Gairdner-Torrens and Flinders Ranges regions. Flowers July to October, with one record for December, presumably in an unusual year. Recorded from limestone areas or from sand.

The apparently simple, cuneate leaves with a shallowly bilobed apex are very distinctive, but no other character difference is apparent from ssp. *aurantiacum* with its distinctly Y-shaped leaves.

Selected specimens annotated by Eichler as *Z. cuneatum*: *T.R.N. Lothian 2041*; *Bates 19341; N.N. Donner 7413,* Serpentine Lakes (AD); *N.N. Donner 7408*, Serpentine Lakes (AD); *N.N. Donner 7413*, 25 Aug. 1980, Serpentine Lakes, (AD); *F. Mollemans 752*, Gypseous Island in the NW corner of Lake Anthony, Commonwealth Hill Station, 140 km west of Coober Pedy (AD); *T.G.B. Osborn s.n.*, 8.viii.1924, Koonamore House, Koonamore (AD, OXF); *D.E. Symon 5605*, 24 km NE of Mundy Ck on road to Murnpeowie Stn. (AD); *D.E. Symon 14567,* Dalhousie, erosion gully in W facing slope of dolomite capped mesa (AD, BRI); *D.E. Symon 16674*, Moralana Stn, limestone rise at Whim Paddock (AD); *L.D. Williams 7739*, 27.5 km NNE Frome Downs H.S. (AD)

Zygophyllum aurantiacum ssp. **verticillatum** H. Eichler ex R.M. Barker, *ssp. nov.*

Subspecies nova *Z. aurantico* ssp. *aurantico* proxima sed differt foliis subsessilibus es sessilibus.

Holotypus: *Hj. Eichler 17952,* 17 July 1964, 5 km S of Leigh Creek, Northern Flinders Ranges, South Australia (AD); isotypi: to be distributed.

Low, spreading, glabrous, perennial shrub, 30–60 cm high and wide. Leaves sessile (bilobed from base); leaflets succulent, linear or narrowly elliptic, 5–20 (-28) mm long, (0.6-) 0.9–1.9 (-3.2) mm wide, not articulated at base, obtuse, acute or truncate at the apex; petiole lacking.

Confined to South Australia where it has been recorded from the Lake Eyre, Gairdner-Torrens, Flinders Ranges and Eastern regions. Flowers July to September.

The leaves, which are sessile and bilobed from the base, appear more like 4 linear leaves arising from each axil at first glance – hence the epithet '*verticillatum*'.

There is a note by Rowell (in the Eichler manuscripts) together with her analysis of the leaf lengths of *Z. aurantiacum* and *Z. "verticillatum"* that as the leaflet type is the only character used to separate the species it seems that *Z. verticillatum* may not qualify for specific rank. Eichler, in unpublished draft keys, treated the taxon at both the specific and subspecific level, but specimens have invariably been annotated by him as *Z. verticillatum.*

Selected specimens annotated by Eichler as *Z. verticillatum: N.N. Donner 133,* 8 km S of Brachina, Flinders Ranges (AD); *Hj. Eichler 12506,* c. 5 km NE of Koonamore HS along mail track to Curnamona (AD); *Hj. Eichler 17950,* Leigh Creek, at the northern end of the township along road to Marree (AD); *Hj. Eichler 17950,* Between Wilpena and Hawker, c. 6.5 km S of Arkaba (AD, CANB); *Hj. Eichler 13036,* Between Hawker and Parachilna, roadside near Hookina Rlwy Stn (AD); *R. Filson 3277,* C 5km E of Alberrie Ck, c. 55 km W of Marree (AD); *R. Hill 454,* Muloorina Stn, Frome River, c. 30 mls N of Marree (AD); *R. Schodde s.n.,* 23 Aug. 1956, Koonamore, 5 mls NE Head Station (AD, duplicates to be distributed); *J.Z. Weber 2716,* Banyeroo Valley northern part, c. 15 km W of headquarters, Oraparinna N.P. (AD)

Zygophyllum tetrapterum H. Eichler ex R.M. Barker, *sp. nov.*

Species nova *Z. aurantiaco, Z. fruticuloso* et *Z. eremaeo* proxima sed differt floribus cum petalis plus minusve sepalis, lobis oblongis nectarii, stylo brevioro, stigmate quattuor-lobo et fructibus venis reticulatis.

Holotypus: *Hj. Eichler 22993,* 11 Sep. 1982, W.A., Austin District. Ca. 27 km WSW of Menzies along the road to Diemals, at edge of salt swamp (CANB390422); isotypi: to be sent to AD, B, G, K, MEL, NSW, PERTH, US.

Decumbent, spreading, light green, glabrous, annual herb, 7–22 cm high, 20–30 cm wide. *Leaves* petiolate; leaflets succulent, oblong, 2–11 mm long, 0.8–1.8 mm wide, continuous with petiole, obtuse-rounded at the apex; petiole 2.5–13 mm long, flattened, similar width to leaflets. *Flowers* single at each node. *Pedicel* 3–4 mm long in flower, erect, 4.5–6 mm long in fruit. *Sepals* 4, lanceolate, 3 mm long. *Petals* 4, yellow, oblanceolate (lacking claw), 2.2–3.3 mm long, similar length to sepals. *Stamens* 8; filaments 1.5–1.7 mm long, gradually dilated to base, without appendages; anthers 0.5–0.7 mm long. *Disc* 4-lobed; lobes free, oblong, succulent, papillose on apex. *Ovary* 4-winged, 4-celled, glabrous, rarely papillose; style 0.1–0.6 mm long; stigma minute, 4-lobed. *Fruit* pendent, 4-winged, 10 mm long, cordate, elliptic with deeply emarginate apex, breaking into 4 winged, 1-celled fruitlets; fruitlets rounded at apex, with 1/2 seeds per cell; wing with wide net-venation; seeds 4.7 mm long, pale brown, elliptic, finely pitted.

Found in Western Australia in the area between Geraldton, Leonora and Southern Cross. Occurs in samphire flats at edge of salt lakes on gypsum, frequently with shrubs of *Atriplex, Frankenia, Selenothamnus* and *Lawrencia.* Flowers August to October.

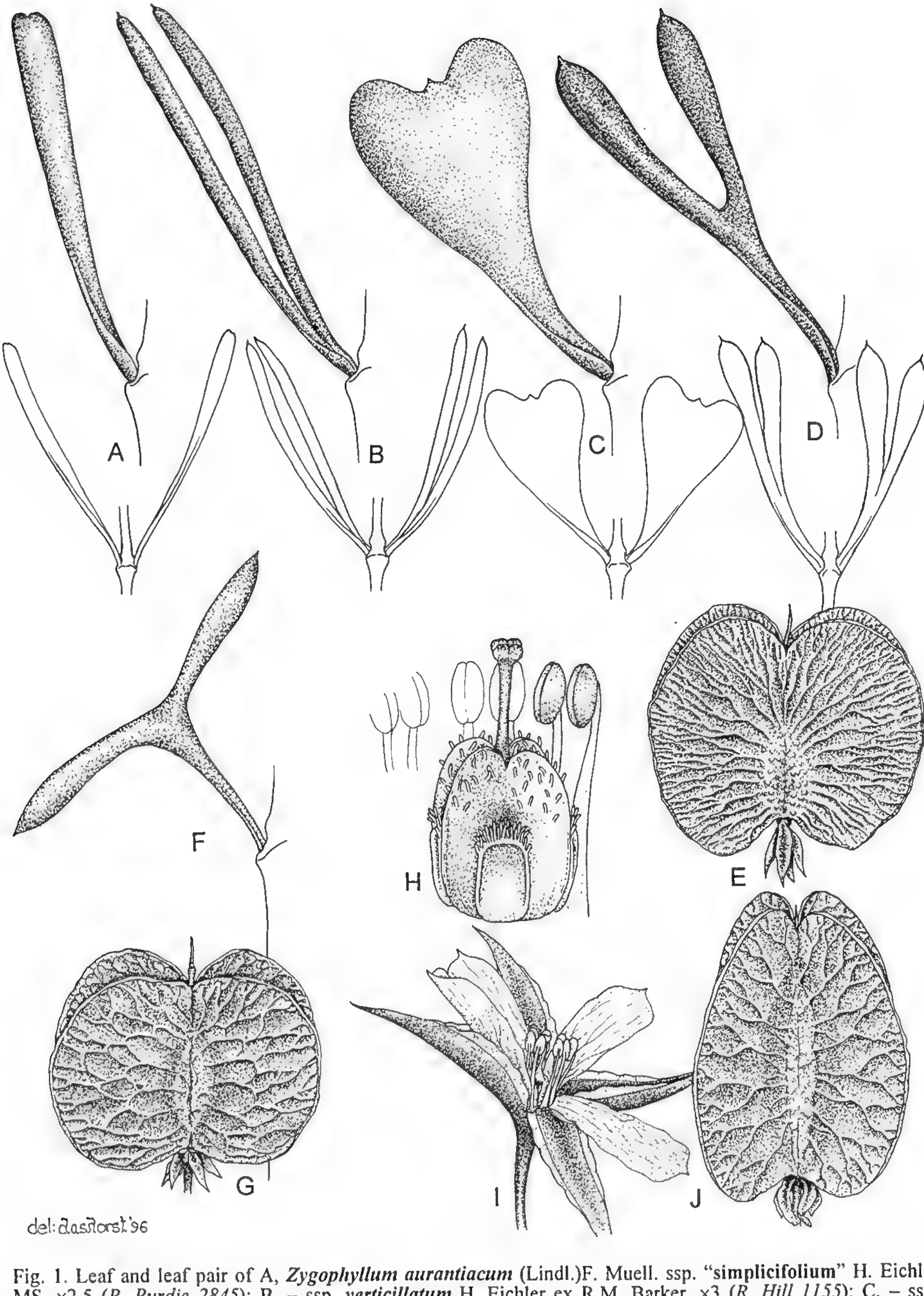

Fig. 1. Leaf and leaf pair of A, ***Zygophyllum aurantiacum*** (Lindl.)F. Muell. ssp. "**simplicifolium**" H. Eichler MS, ×2.5 (*R. Purdie 2845*); B, – ssp. ***verticillatum*** H. Eichler ex R.M. Barker, ×3 (*R. Hill 1155*); C, – ssp. ***cuneatum*** H. Eichler ex R.M. Barker, ×2.5 (*D.E. Symon 16674*); D, – ssp. ***aurantiacum***, ×2.5 (*S. Pillman 003912*); E, fruit of ssp. ***verticillatum*** H. Eichler ex R.M. Barker (*R. Hill 1155*); F, G, leaf, ×2, and fruit, ×2.5, of **Z. "reticulatum"** H. Eichler MS (*P.G. Wilson 7207*); H, I, J, ovary with disc and anthers, ×2.5, flower, ×7, fruit, ×4, of ***Z. tetrapterum*** H. Eichler ex R.M. Barker (*H. Toelken 6088*).

This species can be distinguished from the rest of the *Z. aurantiacum* complex by the flowers shorter than or equal to the sepals, by the 4 oblong disc lobes and by the tiny style and 4-lobed stigma. Markings on the fruit, which tends to be longer than broad, are widely reticulate.

Specimens examined and annotated by Eichler: W.A.: *T.E.H. Aplin 2372*, Lake Miranda (PERTH); *W.E. Blackall s.n.*, Sept. 1939, Yandil Stn (PERTH); *Cole 4/60*, Between Moora and Geraldton (PERTH); *R.J. Cranfield s.n.*, 20 Sept. 1978, Bullfinch (PERTH); *H. Demarz 4586*, 34 miles S of Burtville (PERTH); *Hj. Eichler 23561*, Lake Miranda, S end. 35 km N of Agnew (AD, CANB, PERTH); *C.A. Gardner & W.E. Blackall 826*, Lake Cowcowing, NW of Merredin (PERTH); *J.H. Maiden s.n.*, Sept.1909, Southern Cross (NSW); *A.A. Mitchell 1397*, Lake Nan[uine], 50 km S of MKA (); *K. Newbey 5870*, Southern end of Lake Seabrook, c. 40 km NE of Southern Cross (PERTH); *R.D. Royce 4499*, Comet Vale (PERTH); *P.S. Short 1544*, Southern edge of Lake Miranda, near road running north from Agnew (AD, CANB, MEL, PERTH); *P.S. Short 1988*, c. 7 km N of Vermin Proof Fence in Hamersley Lakes region c. 76 km from Bullfinch along road to Mt Jackson (AD, CANB, MEL, PERTH); *P.S. Short 2198*, Edge of salt lake, western side of road, c. 10.7 km from Coorow, along road to Marchagee (CANB, MEL); *A. Strid 20151*, (B, M, K, PERTH); *H.R. Toelken 6088*, (AD, CANB); *P.G. Wilson 6133*, E side of Lake Moore, c. 85 km N of Koorda (PERTH); *P.G. Wilson 7492*, 30 km NE of Nambi HS which is 65 km NNE of Leonora (PERTH)

A key to the *Z. ammophilum* complex, including a new species, *Z. flavum*

The following is a key, found amongst the Eichler manuscripts, which includes all of the species of the *Z. ammophilum* complex. Four of these species, *Z. confluens, Z. angustifolium, Z. emarginatum* and *Z. simile* were published by Eichler in a precursor paper to the *Flora of New South Wales* (Eichler 1990). *Z. billardierei* is the only other species which can be confused with this group and it can be distinguished from all of the species except *Z. confluens* by its perennial habit and large flowers; it is distinct from *Z. confluens* by the leaflets being articulate with the petiole and is usually confined to coastal localities while *Z. confluens* is usually to be found in inland areas.

1 Perennial. Flowers large. Petals yellow, obovate, 10–12 mm long, distinctly longer than sepals. Leaflets linear, confluent with the petiole (not articulate). Capsule 8–10 mm long. Filaments subulate, abruptly widened at the base. Stamens 8 .... *Z. confluens* H. Eichler

1: Annual. Flowers smaller. Capsule usually shorter than 8 mm.

  2 Petals yellow, oblanceolate, as long as or slightly longer than the sepals. Style distinct; stigma simple. Stamens 8.

    3 Leaflets narrow. Capsule distinctly truncate (i.e. style base sunken), longer than broad.

      4 Leaflets almost terete, linear, distinctly articulate at base. Filaments subulate.Stems and branches very slender, usually supported by other plants. Capsule 6–8 mm long .... *Z. angustifolium* H. Eichler

      4: Leaflets flat, linear-oblong. Filaments winged in lower third. Stems and branches short, self-supporting. Capsule 5–6 mm long .... *Z. flavum H. Eichler* ex R.M. Barker

    3: Leaflets obovate-cuneate, broadest in upper third, distinctly emarginate. Capsule 4–6 mm long, rounded truncate (i.e. style base raised above edges), usually broader than long. Filaments winged in lower third .... *Z. emarginatum* H. Eichler

  2: Petals white, shorter than to as long as sepals. Style very short; stigma 4-branched. Leaflets narrow-oblong. Capsule to 6 mm long.

    5 Stamens 8. Petals broad-ovate-cuneate, rounded to +/- 3-lobed at apex .... *Z. simile* H. Eichler

    5: Stamens 4. Petals narrow-elliptical to narrow-obovate .... *Z. ammophilum* F.Muell.

Zygophyllum flavum H. Eichler ex R.M. Barker, *sp. nov.*

Species nova *Z. ammophili* complexi, a *Z. confluenti* et *Z. billardierei* habitu annuo et floribus parvioribus, a *Z. simili* et *Z. ammophilo* petalis flavibus, sepalis longioribus et stylo distincto, a *Z. emarginato* foliis non emarginatibus et a *Z. angustifolio* habitu non suffulto et filamentis alatis differt.

HOLOTYPUS: *Hj. Eichler 15320,* 9 Nov. 1958, South Australia. Kangaroo Island, south-western part of the island. Near Hanson Bay; c. 4km S of South Coast Road, near the track on the western side of Sou'West River to Hanson Bay; on sand. (AD95914012) ISOTYPI: to be distributed.

Decumbent or straggly, glabrous annual shrub, to 40 cm high, wider than high. *Leaves* petiolate; leaflets usually longer and broader than flattened petiole, succulent, narrowly elliptic or narrowly obovate, often in unequal pairs, 5–15 (-20) mm long, 1.5–4 mm wide, constricted slightly at junction with petiole but not articulated, obtuse at the apex; petiole 5–10 mm long. *Pedicel* 2–4 mm long in flower, 2–5 mm long in fruit. *Sepals* 4, 3–5 mm long. *Petals* 4, light yellow, narrowly obovate, 3.5–5 mm long, usually just longer than sepals. *Stamens* 8; filaments c. 2 mm long, winged at base; anthers mm long. *Disc* 4-lobed; lobes free, semicircular, succulent, papillose on margin, less than half ovary height. *Ovary* 4-angled, 4-celled, glabrous; stigma capitate, not lobed. *Capsule* broadly obtriangular, 5.8–7 mm long, 5.7–7 mm wide, 4-angled, 4-celled, +/- truncate or obliquely truncate, with 1/2 seeds per cell; seeds reddish brown, verrucose, 3–4 mm long; fruiting style 1.3–1.6 mm long.

Flowering August to September for Eyre Peninsula populations but October to January for Kangaroo Island populations. There is some evidence to suggest that very small flowers are produced on the Kangaroo Island collections (personal observation). Ecology: sandy loam, particularly after fire (B. Overton, pers. comm.) or after disturbance.

Specimens examined

SOUTH AUSTRALIA: EYRE PENINSULA: *J.M. Black s.n.*, Tooligee, 110 km N of Port Lincoln, Eyre Peninsula (AD96246128); *J.M. Black s.n.*, 10 Nov. 1915, Tooligee (AD96246140 p.p.); *W. Gill (Conservator of Forests) 29*, Dec. 1911, near Warunda Station, Port Lincoln Railway (NSW144833); KANGAROO ISLAND: *P.G. Wilson 633*, S.W.Kangaroo Island (); *J.B. Cleland s.n.*, 15 km ENE of Cape de Couedic (AD96247266); *E.H. Ising s.n.*, 25 km SW of Kingscote (AD96246159); *Hj. Eichler 18470*, Vivonne Bay (AD); *S.A. White s.n.*, 26 Oct. 1908, Cape Borda, western end (AD97928037 p.p.)

In one preliminary key to *Zygophyllum* Eichler distinguished this species from *Z. emarginatum* by its narrow, almost linear, oblong cuneate leaflets and its distinctly truncate (style base at same level as edges) capsule which is longer than broad. In another key the two species were distinguished by the oblong rather than spathulate disc lobes and by the flattened rather than winged filament bases of *Z. flavum* compared to *Z. emarginatum*.

Z. flavum is distinct from *Z. confluens* and *Z. billardierei* by its annual habit and smaller flowers. It is further distinct from *Z. billardierei* by its non articulated leaflets, a character in which it also differs from *Z. angustifolium*, probably its most closely related species. *Z. angustifolium* usually sprawls within other vegetation whereas this species is apparently compact and self-suporting.

New combination in the *Z. iodocarpum* group of species and clarification of *Zygophyllum* sp. Karratha [J.S. Beard 3508].

Zygophyllum retivalve Domin

Zygophyllum retivalve Domin was described in 1926 from a specimen collected by Clement from between the Ashburton and De Grey Rivers. Within Eichler's manuscripts there are photographs of type collections from both PR and K.

Eichler was sent material of *Zygophyllum* specimens from Karratha which he identified as *Z. cf. retivalve* and this same material has been referred to in the PERTH herbarium as a priority taxon, *Zygophyllum* sp. Karratha [*J.S. Beard 3508*]. Most PERTH specimens on loan to Eichler in CANB have been annotated by him as *Z. retivalve* Domin and there seems little doubt that he considered the Karratha material to belong with *Z. retivalve* Domin.

Specimens annotated by Eichler as *Z. retivalve* Domin: *A.M. Ashby 3206*, 13 June 1970, 26° parallel, N.W.C.H.[North West Coastal Hwy] (PERTH); *A.C. Beauglehole 11675*, 19 Aug. 1965, 27 mls Sw of Tropic of Capricorn, NW coast Hwy (PERTH); *Y. Chadwick 1478*, 1 Sept. 1964, 6 km from Learmonth camp on Wapet

No. 4 well road, south 250 m from Cape Range (PERTH); *P. Glennon 62*, Aug. 1982, Pegs Ck, Karratha (PERTH); *D.W. Goodall 1162*, 12 July 1962, 2 km W of Learmonth (PERTH).

Zygophyllum lobulatum (Benth.)H. Eichler in R.M. Barker, *comb. et stat. nov.*

Zygophyllum iodocarpum var. *lobulatum* Benth., *Flora Australiensis* 1 (30 May 1863) 293; BASIONYM.

Type citation: W. Australia. Champion Bay, *Oldfield.*

Annotations on other specimens and within his manuscripts indicated that Eichler intended to raise *Zygophyllum iodocarpum* var. *lobulatum* Benth. to species level. This taxon is distinct by the presence of a lobe on the outer side at the base of each of the leaflets. It occurs along the Western Australian coast from Perth to Kalbarri and apparently occurs with *Z. retivalve* according to a note on the collection *Eichler 23642. Z. retivalve* is always glaucous in appearance while *Z. lobulatum* is not (noted from comparison of Eichler collections, *Eichler 23622* and *Eichler 23621*, of the two taxa from one locality).

Specimens annotated by Eichler as *Z. lobulatum: D. & B. Bellairs 2181*, 20 Aug. 1978, 14 km S of Kalbarri (PERTH); *Hj. Eichler 23622*, 3 Sept. 1985, S of Coral Bay (AD, CANB, NSW, PERTH); *Hj. Eichler 23642*, 5 Sept. 1985, 26.9 km S of Wooramel (CANB, PERTH); *M. Koch 1673*, Sept. 1905, Watheroo Rabbit fence (MEL); *D.& N. McFarland*, Kalbarri Nat. Pk (CANB275197 & CANB275202, cited in MS); *G.L. Throssell & J.L. Hughes s.n.*, 6 July 1953, Mendel via Mullewa (PERTH); *G.L. Throssell s.n.*, Sept. 1953, Mendel (PERTH, 3 sheets); *Meaton s.n.*, 1888, Upper Swan River (MEL95343).

Draft key to the Australian species of *Zygophyllum* by Hj. Eichler

Note that *Z. tetrapterum* and *Z. lobulatum* are not included in this key. As it appears here, *Z. tetrapterum* would key out to *Z. eremaeum* and *Z. lobulatum* would key out under *Z. hybridum.*

1 Capsule 3-celled, 1-seeded, each carpel with a broad vertical wing. Upper leaves amplexicaul .... *Z. howittii* F.Muell.

1: Capsule 4 or 5-celled. Upper leaves not amplexicaul.

2 Flowers 4-merous. Capsule with 4 vertical angles or wings.

3 Capsule with 4 vertical wings, not truncate; dehiscent in its entirety or in 4 segments corresponding to the carpels. Endocarp and exocarp not separating. Filaments subulate, not winged at base.

4 Flowers small; petals oblanceolate to narrow-elliptic, acute at apex, scarcely exceeding the sepals. Capsule 8–10 mm long; wings very thin; seeds usually only 1–3 per capsule .... *Z. eremaeum* (Diels)Ostenf.

4: Flowers larger, petals obovate, rounded at apex, distinctly exceeding the sepals. Capsule usually larger.

5 Leaves sessile i.e. leaflets in whorls of 4 on the branch, subterete .... *Z. aurantiacum* subsp. *verticillatum* H. Eichler ex R.M. Barker

5: Leaves with petioles.

6 Leaflets lanceolate to narrow-elliptical, distinctly articulate at the base (not confluent in the petiole) .... *Z. fruticulosum* DC.

6: Leaflets oblong or linear, at their base about as broad as the petiole, not distinctly articulate.

7 Leaflets narrow-oblong to linear, about as long as the linear petiole .... *Z. aurantiacum* (Lindl.)F.Muell. subsp. *aurantiacum*

7: Leaflets broad (almost as long), shorter than the cuneate petiole into which they are gradually narrowed....... *Z. aurantiacum* subsp. *cuneatum* H. Eichler ex R.M. Barker

3: Capsule not winged, opening loculicidally. Endocarp and exocarp separating.

8 Capsule and ovary truncate at the summit.

9 Stamens 8.

10 Filaments subulate, not winged at base.

11 Perennial. Flowers large; petals obovate, rounded or slightly emarginate, distinctly longer than the sepals.

12 Leaflets narrow-lanceolate to narrow-elliptical, distinctly articulate at base. Capsule 10–12 mm long .... *Z. billardierei* DC.

12: Leaflets linear, not articulate at base. Capsule 8–10 mm long .... *Z. confluens* H. Eichler [*stenophyllum* in MS]

11: Annual. Flowers smaller; Petals yellow, slightly longer than the sepals, oblanceolate, subacute. Leaflets narrow, almost terete. Capsule 6–8 mm long. Style long with one small stigma at top.................................... *Z. angustifolium* H. Eichler

10: Filaments winged at the base. Petals pale to deep yellow, usually as long as or slightly longer than the sepals.

13 Style very short; stigma usually 4-lobed .... *Z. simile* H. Eichler

13: Style distinct; stigma simple.

14 Leaflets narrow, almost linear-oblong-cuneate. Capsule distinctly truncate, larger than broad... *Z. flavum* H. Eichler ex R.M. Barker

14: Leaflets obovate or cuneate, distinctly emarginate and broader in the upper third. Capsule with rounded truncate top i.e. style base higher than edges, usually broader than long .... *Z. emarginatum* H. Eichler

9: Stamens 4. Style very short, ending in short stigmatic branches. Petals white, shorter or as long as the sepals, obovate, usually rounded or truncate, sometimes slightly emarginate. Leaflets narrow-oblong. Capsule c. 6 mm long.................................. *Z. ammophilum* F.Muell.

8: Ovary and capsule rounded at summit. Filaments winged at base.

15 Capsule sessile, narrow- +/- cylindrical, with 4 erect appendages at the summit .... *Z. prismatothecum* F.Muell.

15: Capsule pedicellate, broad, without erect appendages at the summit.

16 Capsule 14–20 mm long. Leaflets large, 1–3 cm long and broad. Petals 8–15 mm long. Plants usually stout.

17 Leaflets crenate towards the apex (usually with 3 blunt coarse teeth). Annual. .... *Z. crenatum* F.Muell.

17: Leaflets entire. Perennial.

18 Wings of filaments entire, gradually tapering into the filaments. Seeds 1–2 in each cell. Leaflets thick-fleshy, +/- continuous with petiole. Plant with erect main stem. Sepals ovate, c. 3 mm long.............................. *Z. crassissimum* Ising

18: Wings of filaments truncate and denticulate at summit. Seeds 3–5 in each cell. Leaflets thinner, +/- articulate. Plant diffusely branched from ground with ascending branches. Sepals lanceolate, larger .... *Z. glaucum* F.Muell.

16 Capsule 3.5–10 mm long. Leaflets 4–15 mm long. Petals 1–6 mm long. Small annuals.

19 Capsule subglobular, 3.5 mm long, umbilicate at summit. Seed 1 in each cell. Leaflets oblong-cuneate, faintly notched at apex. Petals yellow, slightly longer than sepals .... *Z. humillimum* Koch

19: Capsule obovoid or ovoid, 7–10 mm long, rounded at summit and base, distinctly longer than broad. Seeds 2–3 in each cell.

20 Petals yellow, twice as long as sepals. Capsule obovoid. Leaflets ovate or orbicular, entire.. *Z. compressum* J. Black

20: Petals white, shorter than to as long as sepals. Capsule ovoid-oblong. Leaflets narrowly cuneate, obtuse or faintly notched............. *Z. ovatum* Ewart & J.White

2: Flowers 5-merous. Ovary and capsule with 5 angles.

21 Ovary and capsule truncate at summit. Perennial. Leaflets obliquely ovate, entire, 1.5–4 cm long. Seed 1 per cell.. *Z. apiculatum* F.Muell.

21: Ovary and capsule rounded at summit. Annuals. Leaflets oblong or cuneate, entire, notched, crenate or obliquely lobed.

22 Leaflets towards the apex with coarse blunt teeth. Capsule oblong, c. 12 mm long. Seeds 3–4 in each cell. Wings of filaments not toothed .... *Z. kochii* Tate

22: Leaflets entire or notched at apex.

23 Leaflets with one basal lobe at the outer margin. Capsule c. 10 mm long, upright. Wings of filaments slightly toothed. Seeds 3–6 in each cell .... *Z. hybridum* Tate

23: Leaflets narrowed, not lobed at base. Capsule sub-globular, 5–9 mm long. Seeds 1 or 2 in each cell.

24 Petals not or only slightly exceeding the sepals. Filaments broadly winged, but not toothed. Fruiting pedicels 3–4 mm long. Leaflets oblong-cuneate, notched at apex. Seeds shining, 1 in each cell .... *Z. iodocarpum* F.Muell.

24: Petals about twice as long as sepals. Filaments dilated but not winged in lower half. Fruiting pedicels c. 7–10 mm long. Leaflets entire.

25 Capsule c. 9 mm long. Seeds shining, (?2 in each cell). Leaflets obovate, 6–12 × 2.5–7 mm.. *Z. retivalve* Domin

25: Capsule c. 6–7 mm long. Seed not shining, 1 in each cell. Leaflets obliquely oblanceolate or oblong-elliptical, 6–10 mm long ....*Z. tesquorum* J.Black

TRIBULUS

Within the genus *Tribulus* there is a new species amongst specimens previously assigned to *T. platypterus* Benth. Lawrence (1992) referred to this species in her account of the genus for the Flora of the Kimberleys, stating that Eichler considered that the name *T. platypterus* had "been misapplied to more southerly specimens with prominent corky outgrowths covering all stem surfaces". She therefore used *T. platypterus* for the specimens of the Kimberley and Eichler coined the manuscript name "T. suberosus" for the very corky specimens. Specimens in MEL have been annotated by Eichler with this name and many of the appropriate PERTH specimens have been annotated by Lawrence as "T. suberosus Eichler ms".

While I can confirm that there are two taxa involved here, the correct usage of the name *T. platypterus* has to be confirmed by lectotypification. Within the protologue, Bentham refers to *T. platypterus* as being "glabrous except for the inside of the sepals" and the "older branches in one specimen corky". He further refers to the sepals as being "glabrous outside like the rest of the plant, woolly-hairy inside". From the description, it would appear that Bentham had available to him a mixture of the two species, since the woolly inside of the sepals is characteristic of one of the species while corkiness is characteristic of the other. However he only cited a Gregory collection from the "Hammersleys" [sic].

A MEL isosyntype, MEL79454, a Gregory collection from east of the Hamersley Range, is very distinctly corky, but this specimen was not seen by Bentham. Fruits are present but it lacks any flowers. A specimen definitely seen and annotated by Bentham in Hooker's herbarium at K, represented by a slide in the Eichler manuscripts, does not appear to be corky, but does appear to possess the very woolly-hairy inside of the sepals. This specimen is labelled "Hammersley" range as in the protologue, but is attributed to herb. Mueller rather than to Gregory. It matches well specimens collected by Maitland Brown of the same expedition, since it possesses both flowers and young fruits. The MEL duplicates, MEL79455 and MEL79456, both seen by Bentham are labelled as coming from "E of H [amersley] range, 2–3 feet high - tree. Rocky land" and "brought in from interior - Hammersley Range - Maitland Brown. Tree shrub - Nickol Bay", respectively. Bentham has further annotated the first specimen as "*T. platypterus*/ very different from the African *T. alatus*", and it would be appropriate for choice as lectotype.

It needs to be established whether there is Gregory material in K which might have been seen by Bentham, since he described the older branches in one specimen as being corky. Lectotypification is impossible until this is established but it seems clear that the name *T. platypterus* should be applied to specimens which agree with the Maitland Brown collections i.e. those which are not corky and which are woolly hairy inside the sepals, since the rest of the protologue description clearly relates to this species. This finding confirms Eichler's decision to give a new name to the corky taxon.

Tribulus platypterus Benth., *Flora Austral.* 1 (30 May 1863) 289.

Kallstroemia platyptera (Benth.) Engl. in Engler & Prantl, *Die Natürlichen Pflanzenfamilien* 3 (4) (Dec. 1890) 88.

Type citation: N. Australia. Hammersley [sic] range, *F. Gregory*. *Syntype:* Hammersley range, *herb. Mueller [?Maitland Brown] s.n.* (K); syntype: Brought in from interior - Hammersley Range, *Maitland Brown s.n.* (MEL79456); *syntype*: E of H[amersley] range, Rocky land, *Maitl. Brown s.n.* (MEL79455); *isosyntype:* East of Hammersley Range, *F. Gregory s.n.* (MEL79454) belongs with *T. suberosus* - see below.

Found in the Hamersley area with, according to Lawrence (1992), a single record from the Kimberleys from north of Christmas Creek.

This species does not develop noticeable corkiness except in patches. It does occur together with *T. suberosus* in the Hamersleys (Olsson in litt.to Eichler, 10.iv.1986). *T. platypterus* differs from *T. suberosus* by its internally villous sepals, glabrous pedicels, longer styles and possibly shorter stigmas, easily dissociating fruit, these fruits only with sparse appressed white hairs. A further search for types is necessary before lectotypification is possible.

Tribulus suberosus H. Eichler ex R.M. Barker, *sp. nov.*.

Species nova *T. platyptero* proxima sed differt caulibus suberosis, pedicilis pubescentibus, fructibus tardius dissociantibus et pubescentibus et sepalis sparsius pubescentibus.

Tribulus platypterus auct. non Benth.; Benth., *Flora Austral.* 1 (30 May 1863) 289 p.p. (only as to Gregory collection).

Upright, spreading, subglabrous shrub, 30–100 cm high, up to 200 cm wide; stems with corky bark. *Leaves* in unequal pairs, with (1) 2–4 (5) pairs of leaflets above 2–5 mm long petiole; leaflets obliquely elliptic, sometimes narrowly so, shortly petiolate, very shortly acuminate, glabrous adaxially and abaxially, 3–8 mm long, 2.2–5 mm wide. Flowering pedicel 4–7 mm long, upright, fruiting pedicel 7.5–11 mm long. *Sepals* 6–7.5mm long, glabrous or sparsely sericeous adaxially, sparsely sericeous or patchily villous abaxially. *Disc* glands 5, between sepals and petals. *Petals* 5 (-6), yellow, elliptic to narrowly elliptic, glabrous, 9–12 (-18) mm long, longer than sepals. *Stamens* 10, rarely 11 or 12, in 2 slightly unequal whorls, all fertile or some of them staminodal, at maturity equal to or longer than stigma; filaments 5.5–6 mm long; anthers 0.7–1.1 mm long but other stamens or ?staminodes with anthers linear and twice as long sometimes present. *Ovary* very densely white sericeous, 5-celled; ovules 2 per cell; style and stigma 2–4 mm long, style glabrous; stigma 5-ridged, papillose. *Fruit* a globose 5-winged schizocarp, 13–20 mm long, 18–25 mm wide, very tardily dissociating into 5 2-winged woody cocci, densely pubescent between wings, less so on wings, lacking any spines. **Cork hopbush.**

Found in the rocky hills and ranges from the Hamersleys to the edge of the Gibson Desert and south to Wiluna on a variey of soils. Flowering predominantly April to August, but also sporadically in other months.

Petals on the specimen collected from the Gunbarrel Hwy (*George 5480*) are much longer than usual, but further collections are needed from that area before it can be established whether this is of any taxonomic significance.

Selected PERTH specimens seen (annotated by M.E. Lawrence as *T. suberosus* Eichler MS): NW Coastal Hwy, 38.9 km S of Minilya, *M.E. Ballingall 2003* (PERTH); Cape Range, Charles Knife Road, *J.S. Beard 3574* (PERTH); 9 miles E of Wittenoom, *A.C. Beauglehole 11536* (PERTH); Rocky ranges of N.W.Cape, *T. Carter B1342* (PERTH); C. 23 km E of Wittenoom, *Hj. Eichler 22553* (CANB, MEL, NSW, PERTH); 21.5 miles E of Wangawol Stn. towards Carnegie Stn, *A. Fairall 1946* (PERTH); Yampire Gorge, Hamersley Range, *C.A. Gardner 12302* (PERTH); 25 miles WNW of Wiluna, *C.A. Gardner 2381* (PERTH); 25 miles WNW of Wiluna, *C.A. Gardner 2381* (PERTH); 19 miles W of Mt Nossiter, Gunbarrel Hwy, *A.S. George 5480* (PERTH); Cape Range, c. 1 mile S of lighthouse, *A.S. George 2558* (PERTH); Cape Range, S of Yardie Creek, *G.J. Keighery & N. Gibson 277* (PERTH); 20 km N of Roy Hill, c. 107 km N of Newman, *K. Newbey 10090* (PERTH); Kennedy Range, southern end by hill K39, c. 24 km NW of Gascoyne Junction, *P.G. Wilson 8440* (PERTH);

Acknowledgements

Hansjoerg Eichler was a personal friend to my husband Bill and me, as well as an esteemed botanical colleague and so there is a great deal of regret that he did not live to publish the species he had long recognised in *Zygophyllum*. I would have preferred that the authorship of the new species published here be his alone but the lack of any descriptions made this impossible.

Hansjoerg would have wished to acknowledge the contribution of Alison Rowell and Terena Lally, both of whom worked with him on Australian Biological Resources Study funding at CANB, the former on *Zygophyllum* and the latter on *Tribulus*. Terena also gathered together his manuscripts after his death for which I am grateful. I am also sure that Hansjoerg would have wished to acknowledge the long term help and support of his wife Marlies in a group of plants in which he had an interest since his first arrival in Adelaide.

My thanks are to the staff of all Australian herbaria who facilitated the return of specimens to AD, but particularly those of CANB and AD, to the Australian Biological Resources Study who supported this project, to Bill Barker for his comments on the manuscript and to Hansjoerg Eichler, whose standards I can only aspire to emulate.

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THE ESCAPE OF *STIPA PAPPOSA*

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Abstract

A history of the occurrence of *Stipa papposa* in South Australia is given. The species is described together with notes on distinguishing features.

In the late 1930s, the early years of the Waite Agricultural Research Institute, there was considerable interest in obtaining pasture plants. In 1939 Professor H.C. Trumble travelled to America and, when visiting Prof. B.A. Madson, Division of Agronomy, University of California, Davis, arranged for a selection of seeds to be sent to Adelaide. Prof. Trumble himself brought roots of Kikuyu grass with him on the boat trip back.

A letter survives in the Waite Archives from Prof. Trumble dated 16 April 1940 to Prof. Madson and saying *inter alia* "... seeds so kindly sent from Davis on my behalf have now arrived".

A list of the species involved has not been traced but in the ADW herbarium now incorporated in AD is a specimen of *Stipa papposa* with the label "grown in a box at glasshouse W.1. Seed from Prof. Madson, Univ. Calif. Davis, coll. C.A.N.S. [= C.A. Neal-Smith] 10.i.1941."

This must have been planted later in the grass garden which consisted of numerous small plots of pasture species and used for demonstration, teaching and minor trials.

Stipa papposa was grown there for some years as another specimen labelled "Waite Inst. Grass Garden J.W. Banfield 3/4/1950" survives. It is not known how much longer it was cultivated before being dug up.

In 1968 several patches were noticed in the Waite Arboretum. This is close to the Grass Garden and was at that time grazed by sheep. Several of these were described as "large" with three others described as "few". These plants were destroyed by digging them out. The localities were all recorded as adjacent to numbered trees and in some of these early infestations no further plants have appeared.

Vegetatively the *Stipa* plants are similar to fine-stemmed *Danthonia* species and are not readily spotted unless in flower, especially when grazed by sheep. Flowering of the *Stipa* is in late summer, responding to summer rains.

During 1973, 1985, 1991, 1993–1995 at least 25 patches were recognised, some large, others small. These were all spaded out. After 1991 the Arboretum was mown and not grazed and the search for *Stipa* plants was intensified. The removal of sheep has resulted in an increase in *Danthonia* making it somewhat more difficult to spot the *Stipa*. During this period it was not recorded as naturalised as it was still confined to the Arboretum and it was hoped to eradicate it.

However in 1994 a specimen was brought in by Michael Sardo from the South Parklands bordering Adelaide. Inspection revealed about 16 plants one of which was 15–20 cm in basal diameter and probably several years old. All were spaded out.

Stipa papposa Nees, Agrost. Brasil. 377 (1829); Doell in Martius, Fl. Bras. 2, 3: 11, tab. 2 (1878); Burkart, Fl. Ill. Entre Rios 2: 144, fig. 47 (1969); Zuloaga et al., Cat. Fam. Poaceae en la Rep. Argentina 147 (1994), nom. illegit.

Calamagrostis plumosa Spreng., Syst. Veg. 1: 253 (1825), according to Nicora, Fl. Patagonica 3: 312 (1978).

Type: Montevideo [Uruguay], *Sello s.n.* (n.v.).

S. delilei Steudel, Syn. Pl. Glum. 126 (1854). Nom. nov. for *S. papposa* sensu Delile, Ind. Sem. Hort. Monsp. 7 (1849); treated as a synonym for *S. papposa* Nees by Nicora l.c.

Caespitose perennial 25–80 cm high, sometimes branched at lower nodes. *Culms* erect or geniculate at the base, terete, ribbed, 0.5–2 mm wide near the base, not compressible, glabrous, green; nodes 2–6, glabrous, exserted. *Leaf sheaths* tightly enveloping the culm, sometimes becoming loose upwards, glabrous. *Ligule* truncate, membranous, 0.1–0.5 mm long, glabrous; auricles with ciliate hairs 1.5–2.5 mm long. *Leaf blade* flat or inrolled, 4–20 cm long, 0.2–2 mm wide, glabrous or sparsely scabridulous, ribbed especially on the adaxial surface. *Panicle* 10–20 cm long, 1–3 cm wide (excluding awns), base enclosed or exserted, contracted, sparse; axis terete, angled above, glabrous, sometimes scabrous above; pedicels 2–20 mm long, flattened, scabrous. *Spikelets* 6–10 mm long (excluding awns), slightly gaping. *Glumes* membranous and translucent, 1-nerved, 5–7 mm long, 0–2 mm shorter than the lemma or rarely slightly longer, the lower 0.5–2 mm shorter than the upper, narrow, glabrous. *Lemma* narrowly fusiform, 6–9 mm long (including callus), smooth, light brown or pinkish, scabrous except on the distal 1.5–2 mm where there are 4–8 mm long spreading white hairs; coma absent. *Callus* 1–1.5 mm long, scarcely curved at the apex, sericeous with c. 0.5 mm long white hairs extending in a line shortly up the lemma. *Awn* 1.5–3 cm long, twice bent, c. 0.2 mm wide near the base; column 3.5 mm long, minutely and sparsely scabrous; bristle minutely scabrous. *Palea* c. 20% the length of the lemma, hyaline. *Anthers* c. 3.5 mm long. *Caryopsis* narrowly fusiform, 3–5 mm long. Fig. 1.

Diagnostic features

Within species of *Stipa*, and the allied genus *Nassella*, native or naturalised in Australia the long hairs on the lemma are unmistakable, Clayton & Renvoize (1986) refer to the glumes' being shorter than the lemma as being unique, although in a few specimens examined the glumes were actually longer.

Vegetatively, in the field, the growth form resembles that of a *Danthonia* but the *Stipa* can be distinguished by the somewhat wiry stems that remain green and photosynthetic after shedding its seeds.

The species is illustrated in both Caro (1966) and Caro & Sanchez (1973) the latter including epidermal and leaf section details.

Distribution

It was first collected in Montevideo (at one time in Brazil, but currently in Uruguay) but has since been collected in southern Brazil, Uruguay, central and eastern Argentina and Chile. The only previous record outside of South America found was from Cape Town (1963 and 1980) in Gibbs Russell *et al.* (1990). In South Australia only in a south eastern segment of Adelaide.

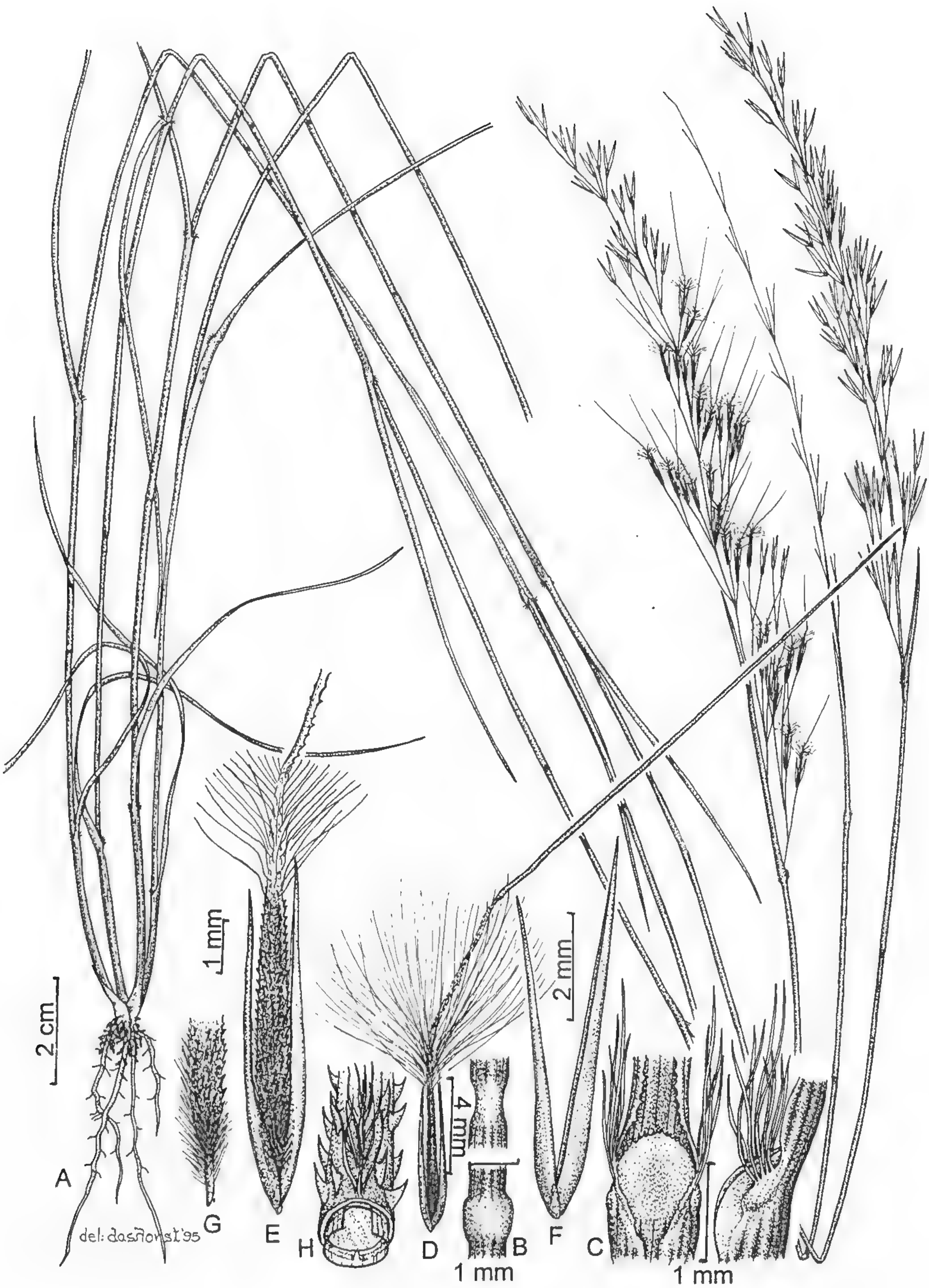

Fig. 1. ***Stipa papposa*** Nees. A, habit; B, nodes; C, two views of ligule; D, spikelet; E, spikelet enlarged; F, glumes; G, tip of lemma and callus; H, section through lemma and palea. (*C.A.N. Smith 4317*; AD 98667535).

Nomenclature

Nees (1829), in transferring *Calamagrostis plumosa* Spreng. to *Stipa*, failed to retain the epithet *plumosa* and renamed the species *S. papposa* which is, therefore, an illegitimate name.

Stipa plumosa was subsequently taken up by Trinius (1836) for another species so that Sprengel's epithet can no longer be used in *Stipa*. It is not known whether or not by 1829 Trinius already intended to use the name *plumosa* but, even if Nees avoided the combination for this reason, this would not make his new name legitimate.

It is possible that *S. delilei* Steudel may be the earliest available name, but it would be preferable for someone with a greater knowledge of the species and its associated literature to make a decision on the correct name. It is proposed that the apparently illegitimate name, *S. papposa*, be used until all taxonomic and nomenclatural issues (possibly including conservation) have been fully considered.

Other introduced species

The genera *Stipa* and *Nassella* appear closely related and some species of *Stipa* have recently been transferred to *Nassella*. Despite the cosmopolitan distribution of the large genus *Stipa* and the more restricted *Nassella*, it is of interest that seven of the species now naturalised in Australia come from South America and the eighth from southern North America. The potential for species of those genera to become established in Australia is demonstrated and now reinforced by the difficulty in eradicating *Stipa papposa*. The present record Harden (1993), Walsh & Entwistle (1994) and Simon (1993) is as follows:-

Nassella hyalina (Nees)Barkworth [*Stipa hyalina*] – NSW, Victoria
N. leucotricha (Trin. & Rupr.)Pohl [*Stipa leucotricha*] – Victoria
N. megapotamica (Spreng. ex Trin.)Barkworth [*Stipa megapotamica*]– NSW
N. neesiana (Trin. & Rupr.)Barkworth [*Stipa neesiana*] – NSW, Victoria, S.A.
N. trichotoma (Nees)Hack. ex Arechav. [*Stipa trichotoma*] – NSW, Victoria, Tasmania
Stipa brachychaeta Godr. – NSW, Victoria, Tasmania
S. caudata Trin. – NSW, Victoria, Tasmania
S. papposa Nees – S.A.

Specimens examined

SOUTH AUSTRALIA: *Banfield s.n.*, Waite Institute grass garden, 3.iv.1950 (AD); *Sando s.n.*, South Parklands near Parklands Creek west of Hutt Road, 31.xii.1994 (AD); *Neal-Smith s.n.*, Grown in box in glasshouse, Waite Institute; seed from Prof. Madson, Calif. Univ., 10.i.1941. (AD); *Symon 15232*, Waite Arboretum adjacent to trees, 43B/46, i.1994 (AD, BRI, CANB).

ARGENTINA: *Yuan B. Daguerre 239*, pdo. Las Flores, 2.xii.1926 (AD); *Dr P. Dusén s.n.*, Prov. Buenos Aires, de la Ventana, 29.xi.1904 (AD).

CHILE: *O. Boelcke 3945*, prov. Aconcagua, Zapallar, cerro Francés, 4.i.1949 (AD).

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Bob Makinson, Australian Botanical Liaison Officer at Kew, 1995/96, made a detailed investigation of the nomenclatural problems of the name Stipa papposa and provided much useful advice and literature.

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NOVELTIES AND TAXONOMIC NOTES RELATING TO *HAKEA* SECT. *HAKEA* (PROTEACEAE), MAINLY OF EASTERN AUSTRALIA

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Abstract

Keys to the species of the informal "*H. sericea*" and "*H. nodosa*" species groups of Sect. *Hakea* are provided. In the former group new taxa described are: a new subspecies ssp. *sericipes* of the eastern and western perimeter of the widespread semi-arid Australian species *H. leucoptera* R. Br.; *H. actites* of coastal regions of southern Queensland and northern New South Wales and *H. macrorrhyncha* of a localised granite area on the Queensland - New South Wales border, both previously confused with *H. propinqua* Cunn.; *H. ochroptera*, a northern New South Wales counterpart of *H. macraeana* F. Muell. from the Dorrigo area; two new subspecies of *H. decurrens* R. Br., previously confused with *H. sericea* Schrad. & J. Wendl., ssp. *physocarpa* from western and central Victoria, the plant naturalised in South Australia, and ssp. *platytaenia* of coastal regions of eastern Victoria and south-eastern New South Wales. Of overseas introductions till now all considered to be *H. sericea*, substantial material has been seen only from South Africa, which is all true *H. sericea*; the few specimens from other countries indicate that *H. sericea* occurs in New Zealand and Norfolk Island and *H. decurrens* ssp. *physocarpa* in Portugal. In the "*H.* nodosa" group *H. propinqua* is shown to comprise two distinctive species, true *H. propinqua* a tall shrub confined to the Sydney region and lower Blue Mountains and *H. pachyphylla* Sieber ex Spreng., a small shrub of the higher Blue Mountains and possibly the Budawang Ranges. Accepted names and synonyms are typified where needed.

The species of *Hakea* which have terete or, less commonly, flat, usually rigid leaves, inflorescences in axillary umbelliform clusters on short rachises, small, white to yellow flowers or larger, red or pink flowers with an oblique-conical or lateral pollen-presenter, and woody fruits with a pair of conspicuous or inconspicuous horns form the section *Hakea*. Those species with white to cream, smallish flowers, which constitute the majority in the group in south-eastern Australia, are often known collectively as needlewoods.

This paper presents the changes resulting from a revised taxonomy of the terete-leaved species of *Hakea* Sect. *Hakea* with white to yellow flowers in south-eastern Australia, aimed at providing new names for use in the *Flora of Victoria* (R.M. Barker, W.R. Barker and Haegi, in press) and the *Flora of Australia* (R.M. Barker, W.R. Barker and L. Haegi, in preparation). Descriptions are provided for those taxa for which the circumscription has been reconstituted. Previous papers have clarified the taxonomy of other parts of the section (W.R. Barker 1985, 1986, 1989; R.M. Barker 1990, 1991). Some reference to the conclusions made in this paper was given in my notes appended to accounts of the relevant species in the *Flora of New South Wales* treatment of the genus (Harden 1991).

An account of the genus has been prepared for the *Flora of Australia*, but with descriptions being restricted in this publication, full descriptive data are left to other hard-copy and electronic publications in preparation. A cladistic analysis encompassing all taxa within the genus and taking into account the rest of the tribe Grevilleeae is also being undertaken. Formal presentation of a revised infrageneric framework awaits its completion.

For consistency, infraspecific taxa are treated at the one level subspecies in our work in *Hakea*.

A conservation status rating is proposed for those taxa which are considered rare, following the criteria of Leigh, Briggs & Hartley (1981).

Dimensions are measured from dried material. Perianth length is measured from the base of the torus to the apex of the limb or the most distal part of it if it is recurved. Pistil length

is measured straightened. The term *tomentose* indicates that the arms of the hairs are ascending or suberect ("raised"), in contrast with *appressed-pubescent* and *appressed-sericeous* conditions. The longitudinal groove on the underside of the leaves of some needlewood species may not be apparent on all leaves of a plant. The fruit opens into two woody valves, each with the inner face bearing a seed borne in the *seed cavity*. The orientation of the seed with respect to the axis of the fruit (taken from the stalk to the persistent base of the style, the *apiculum*) is of diagnostic use. On either side of the seed cavity are two contrasting layers of wood, a *pale wood* zone, itself of two or more layers, and a *red-brown wood* zone. These vary between taxa in width and relative width. The *beak* is the attenuated region distal of the main swollen *body* of the fruit, well demarcated in most species of *Hakea* and marking the point where one or more layers of pale wood reach their distal limit; it is often decurrent down one or both sides of the fruit body. The extent of the beak has been defined as tiny where less than 0.05 the area of the fruit, small where up to 0.2, and moderately large where up to 0.5. The *horns* are a pair of hard points which project obliquely forwards from just behind the fruit apex, and are prone to breakage and wear.

Key to the needlewoods (the "*H. sericea* group"), mainly of eastern Australia

1. Branchlets and leaves densely villous. Fruits with seed borne at right angles to direction of stalk. .... ***H. gibbosa*** (p. 207; Fig. 2, J–L; Map 2)
1. Branchlets and leaves often pubescent when young, usually glabrescent, but not villous. Fruits with seed borne in same direction as stalk or directed obliquely forward from it.
    2. Perianth hairy.
        3. Leaves not grooved below.
            4. Fruit coarsely rugose or tuberculate. [Perianth 3.5–6 mm long; pistil 8–10.5 mm long; pedicel 3.5–5.5 mm long; rachis 1–2 mm long, white-tomentose; fruit 2.3–2.7 mm long.] .... ***H. lissosperma*** (Fig. 1, O–Q; Map 2)
            4. Fruit smooth, sometimes slightly pusticulate.
                5. Perianth 2.5–3 mm long. Pistil 7–7.5 mm long. Pedicel sparsely appressed pubescent. [Rachis 1.2–5 mm long, densely brown-pubescent, sometimes covered by sparse white hairs; leaf mucro uncinate; fruit obscurely horned; seed wing grey-yellow.] .... ***H. kippistiana*** (p. 180; Map 1)
                5. Perianth 3–6 mm long. Pistil 7–10 mm long. Pedicel densely appressed or raised pubsescent.
                    6. Rachis 1–3 mm long, brown-pubescent. Leaf mucro strongly uncinate. Fruits usually clearly horned; seed wing grey-yellow to blackish. .... ***H. tephrosperma*** (p. 180; Fig. 1, A–H; Map 1)
                    6. Rachis 6–14 mm long, white-tomentose or with an appressed layer of white and brown hairs. Leaf mucro porrect or uncinate. Fruits often obscurely horned; seed wing cream to brown-white, sometimes darker at the base. .... ***H. leucoptera*** (p. 180)
        3. Leaves grooved below.
            7. Branchlets tomentose, persistent to flowering. Fruit body rugose-reticulate; beak long; horns obscure, less than 1 mm long. Perianth moderately to densely tomentose. .... ***H. macrorrhyncha*** (p. 184)
            7. Branchlets appressed-pubescent, persistent to flowering or glabrescent. Fruit body pusticulate; beak short; horns prominent, 1–3 mm long. Perianth sparsely appressed sericeous. .... ***H. macraeana*** (p. 206; Fig. 1, K–N; Map 2)
    2. Perianth glabrous.
        8. Rachis 6–14 mm long .... ***H. leucoptera*** (p. 180)
        8. Rachis 0.6–4 mm long.
            9. Fruit 4.3–5.5 cm long, 3–3.5 cm wide. Flowers 6–12. [Pistil 8–12 mm long.] .... ***H. constablei*** (p. 187; Fig. 1, R–T)
            9. Fruit 1.8–4.0 cm long, 1.0–3.0 cm wide. Flowers 1-6 (to 8 in *H. lissosperma*).
                10. Pistil over 9 mm long.
                    11. Horns on fruit 1–5 mm long; seed wing decurrent fully down both sides of the seed body, more narrowly on one side. .... ***H. decurrens*** (p. 189)
                    11. Horns on fruit obscure; seed wing decurrent partly down one side of the seed body, fully down the other.

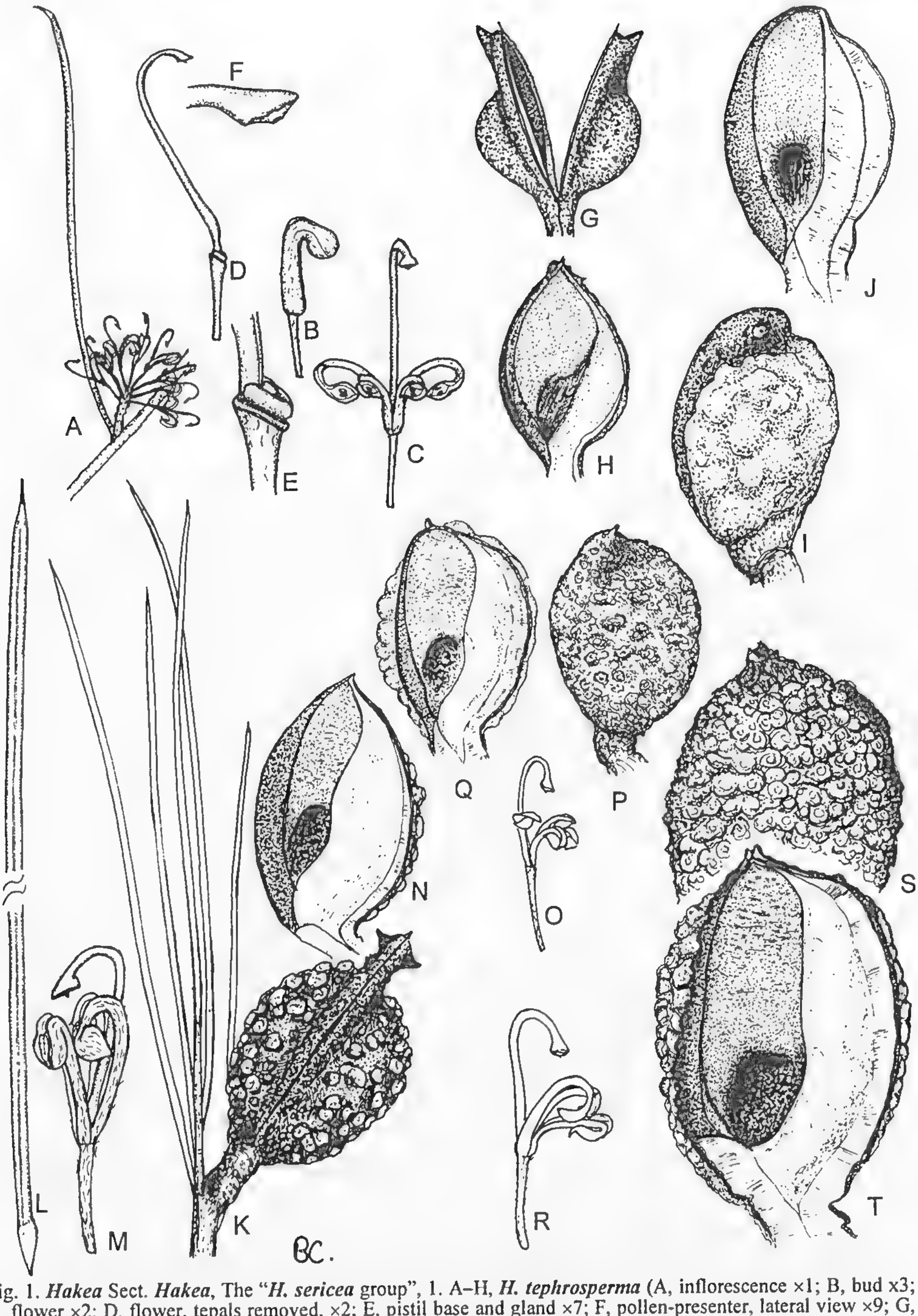


Fig. 1. ***Hakea*** Sect. ***Hakea***, The "***H. sericea*** group", 1. A–H, ***H. tephrosperma*** (A, inflorescence ×1; B, bud x3; C, flower ×2; D, flower, tepals removed, ×2; E, pistil base and gland ×7; F, pollen-presenter, lateral view ×9; G, fruit ×1; H, valve, inner face ×1). I--J, ***H. actites*** (I, fruit, lateral view ×1; J, valve, inner face ×1). K–N, ***H. macraeana*** (K, fruiting branchlet ×1; L, leaf, abaxial side ×3; M, flower ×4.5; N, fruit, inner face ×1). O--Q, ***H. lissosperma*** (O, flower ×2; P, fruit ×1; Q, valve, inner face ×1). R–T, ***H. constablei*** (R, flowers ×2; S, fruit ×1; valve, inner face ×1). (A–H, *Purdie 5840*; G–H, *Ising AD966090454*; I–J, *Johnson NSW 5402...*; K–L, N, *Parris NSW190768*; M, *Constable NSW25757*; O, *Long 941*; P–Q, *Long 360*; R–T, *Foster NSW54031*). (Del. B. Chandler).

12. Seed wing light brown (young?) to off-white. Flowers 1–6......... *H. ochroptera* (p. 187)
12. Seed wing black to dark brown. Flowers 6–8. ...... *H. lissosperma* (Fig. 1, O–Q; Map 2)

10. Pistil less than 9 mm long.

13. Pedicels villous or hirsute. Horns on fruit 1–3 mm long. Seed wing decurrent sometimes fully down one side of seed body only, on the other side not at all or more narrowly and partly to fully.. *H. sericea* (p. 196)

13. Pedicels appressed-sericeous. Horns on fruit obscure.

14. Fruit body smooth or coarsely pusticulate; beak obliquely decurrent down one side, smooth. Seed wing decurrent fully down both sides of the seed body. Pedicels 1.8–3.0 mm long. Pistil 6.7–8 mm long... *H. actites* (p. 180)

14. Fruit body coarsely rugose or tuberculate; beak transverse, its surface like the body. Seed wing decurrent partly, down one side of the seed body. Pedicels 3.5–5.5 mm long. Pistil 8.0–10.5 mm long.............................. *H. lissosperma* (Fig. 1, O–Q; Map 2)

Infraspecific variation in *H. leucoptera* R. Br.

H. leucoptera belongs to a group of closely allied taxa which shows variation in branchlet, pedicel and perianth indumentum, fruit size and shape, conspicuousness of the horns and colour of the seed. It is spread widely across temperate arid and semi-arid regions of the Australian continent, though more sporadically in Western Australia. The distinction of *H. tephrosperma* R. Br. from *H. leucoptera*, the misapplication of *H. vittata* R. Br. (now in a different infrageneric group: R.M. Barker, W.R. Barker & L. Haegi, in preparation) to the former, and the misapplication of *H. kippistiana* Kippist & Meisn. to glabrous-flowered forms of *H. leucoptera* were clarified in W.R. Barker (1985, 1986).

H. kippistiana is a species confined to south-west Western Australia between Cunderdin and Madura (Map 1) and is distinguished from *H. leucoptera* and *H. tephrosperma* by its smaller flowers (perianth 2–3.5 mm long).

The few specimens from the Gibson Desert region of central Western Australia have robust leaves of *H. leucoptera* but smallish fruits similar to those of *H. kippistiana* (Map 1). Flowering material is required to establish their taxonomic affinity.

H. leucoptera is the most widespread of the three species. It comprises two geographical races classified as subspecies. For the major part of its range across central temperate semi-arid to arid Australia its rachis is woolly pubescent. This race varies within populations in its glabrous or pubescent perianth. A second race with appressed pubescent rachises occupies the eastern semi-arid regions of the species range. Collections with similar rachis indumentum occur on the western margins of the continent. Further work is required to confirm that they belong to the same taxon.

H. leucoptera R. Br. ssp. **leucoptera**

Indumentum on rachis raised-tomentose to woolly tomentose. Perianth glabrous or pubescent.

Distribution (Map 1): Widespread across the arid and semi-arid regions of central and eastern Australia, occurring in all mainland states except Western Australia.

Notes

Small fruited collections of *H. leucoptera* occur sporadically in the peninsula regions of South Australia. While their small fruits are similar to those seen in *H. kippistiana*, they otherwise match the attributes of *H. leucoptera*.

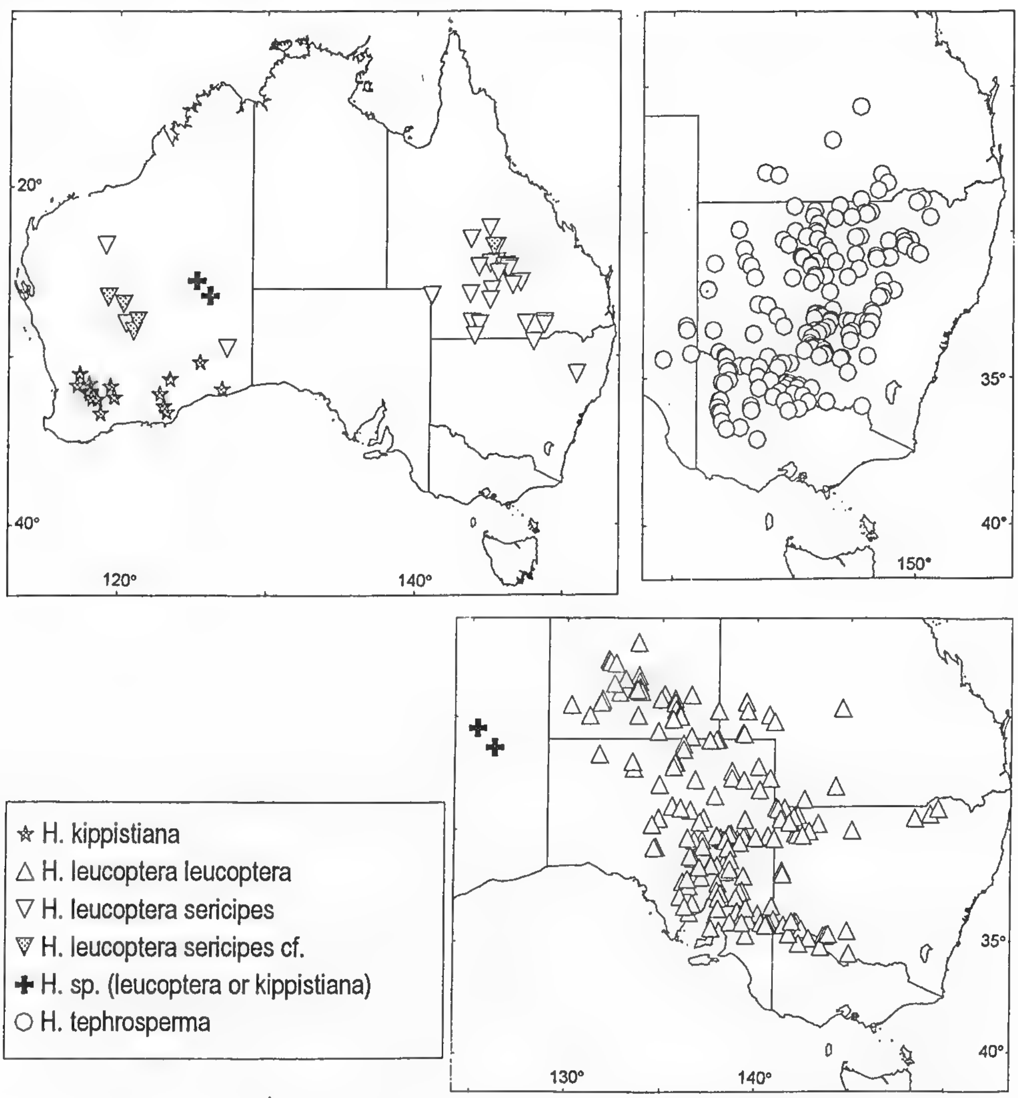
Specimens examined (501 seen): See a selection listed in W.R. Barker 1985.

H. leucoptera R. Br. ssp. sericipes W.R. Barker, *ssp. nov.*

A ssp. *leucoptera* rachidi pilis appressis tecta differt.

Holotypus: *W.R. Barker 5587*, 26.viii.1988, Queensland, Warrego District, c. 16 km by road NE of Hungerford on road to Eulo; localised (flowering) stand of c. 20 plants; *Acacia aneura* tall semi-open woodland with scattered emergent *Eucalyptus populnea* over *Hakea leucoptera* - *Eremophila longifolia* over *Eremophila* sp. low shrubs; deep red sand hardpan; shrubs with several thick main branches from base, ascending; old bark rough, but distally for most part smooth; young shoots rust brown on midgreen; leaves blue-grey ?through appressed tomentum, dark green on older parts; rachis appressed rust brown; pedicel, limb in bud, ovary and distal half of style mid green; corolla tube, style cream-white; all fruits old and open, even when distal to insertion on branch is a flowering branch; single specimen per plant collected; flowers with foul (rubbish bin) odour attracting many flies even towards dusk, AD. *Isotypi*: several for distribution.

Indumentum on rachis appressed-pubescent.



Map 1. Distribution of the "*H. sericea* group", 1. ***H. leucoptera*** ssp. ***leucoptera***, ***H. leucoptera*** ssp. ***sericipes***, ***H. tephrosperma*** and ***H. kippistiana***.

Distribution (Map 1):

Occurring on the western slopes of the Great Dividing Range and adjacent plains in northern New South Wales and central and south Queensland and in western Western Australia.

Notes

1. A number of fruiting specimens of *H. leucoptera* from Western Australia resemble ssp. *sericipes* but lack inflorescences or adequate rachis remnants to be sure of their identity (Map 1, as ssp. *cf. sericipes*).
2. The subspecific epithet is a subtantive and derives from the Latin *sericus*, silken, and *-pes*, foot, alluding to the appressed shiny indumentum on the pedicels.

Selected specimens examined (41 seen):

WESTERN AUSTRALIA. ***Pilbara***: *A.A. Mitchell 326*, 30.iv.1977, 10 km N of the Prairie Downs H.S. on the Rhodes Ridge R track; Fortesque District, PERTH. – ***Austin***: *H. Demarz 7251*, 21.xi.1978, 3 km S of Agnew, PERTH. – ***Nullarbor***: *Serventy D.L. 4511*, 17.viii.1960, 4 m NE of "The Station", just before ... sandhills, PERTH. – ***Questionable***: ***Menzies***: *J. Staer s.n.*, ii.1911, Middleton Beach, [Albany], NSW 190718, NSW 190717.

QUEENSLAND. ***Mitchell***: *G.R. Beeston 1184C*, vii.1975, Warlus Area C Site No. 108 15 km NNE of Tambo, BRI. – *S.T. Blake 10378*, 6.xii.1935; Geera, E of Barcaldine, BRI. – *W. Cullen per R.H. Cambage 5*, vii.1914, Geera, NSW. – *D. Davidson 228*, vii.1952, 50 m NW of Longreach, BRI. – *S.L. Everist 1890*, x.1939, Blackall, BRI. – *W.T. Jones 1894*, 15.iv.1961, Tambo, CANB. – *N.F. Pembroke s.n.*, 23.ix.1965, "Bowen Downs"-"Corinda" stock route, BRI 81868. – *C.T. White 12413*, 12.xi.1943, Enniskillen, BRI (2 sheets). – ***Gregory South***: *S.T. Blake 5444*, 22.iv.1934, Earlstoun, between Quilpie and Windorah, BRI. –*D.E. Boyland 3126*, 8.vii.1971, 212.8 km WNW of Eromanga, BRI. – ***Warrego***: *L.H. Cockburn 31*, 4.ix.1963, Near Dynevor Lake, Thargomindah, BRI. – *J.K. Cull s.n.*,11.xii.1961, T. Arden's property "Akaray", BRI. – *C. Sandercoe 159*, 1.v.1979, Ambathala Range area, 50 km E of Adavale; 3.5 km N of Telephone line on Stockmans Bore road, BRI. – *J.P. Stanton s.n.*, 19.ix.1971, Between Lakes Wyara and Numalla, c. 48 km NW of Hungerford, BRI 141258. – *R.M. Woolcock s.n.*,18.iii.1960, "Lanherne", Cheepie, BRI 24335. – ***Maranoa***: *G.H. Allen s.n.*, 5.xi.1941, 19 km (12 m) E of St George, NE 2506. – *K. Roach 9*, xii.1981, 5 km S of Bollon, BRI.

NEW SOUTH WALES. ***North-Western Plains***: *S.W. Jackson s.n.*, xi.1911, 40-50 m[iles] NW of Collarenebri, NSW 190685, NSW 190733, NSW 190734. – *M.B.E Sampson s.n.*, xii.1909, Moor Creek, Tamworth, NSW 190740, NSW 190741, AD 98720338, AD 98720339, PERTH. – ***North-Western Slopes***: *J.T. Waterhouse s.n.*, 30.xi.1956, Clylie, Merrywinebore, NSW 190684. – ***South-Western Slopes***: *R. Roe s.n.*, 26.x.1940, 46 m North Morven, CANB 3173.

Two new species previously confused with *H. propinqua* Cunn. from north-eastern New South Wales and south-eastern Queensland

The name *H. propinqua*, a species allied to *H. nodosa* (see p. 199), has been misapplied previously to two quite unrelated unnamed species of north-east New South Wales and south-eastern Queensland, one common to near-coastal heath("wallum"), the other restricted to a small region of granite near Torrington on the border between the two states. The existence of the unrecognised species *H. pachyphylla* Sieber ex Spreng. related to but confused with *H. propinqua* in the Sydney - Blue Mountains area (see p. 199) no doubt contributed to the confusion, at least in New South Wales: its fruit is similar to these northern species. Queensland botanists tended to confound the more common of the two species, that occurring in wallum, with *H. gibbosa* (Sm.)Cav., which is endemic to the Sydney region; their confusion also of the isolated most northerly occurrences of *H. sericea* with *H. gibbosa* (Ross 1986) would have compounded the problems. It has only been in more recent times that the rarer second species has been discovered in their state (Mr W. MacDonald, pers. comm. 1987; MacDonald et al. 1995).

Nevertheless, it is clear from the literature that some botanists have for some time considered the relationships of the two existing species to be problematic. Annotations on herbarium specimens indicated that the Torrington or Wallangarra species has long been

suspected to be distinct, starting with Boorman, who annotated a Torrington collection (*NSW182514*) as being "less branched than the Port Jackson forms" of *H. propinqua*. From specimen annotations dated 1955 Dr L. Johnson debated a concept of species similar to that adopted here, noting on a sheet of fruiting material that the Wallangarra species was a "form ... conspecific with the type form [of *H. propinqua*] though it differs from the related 'wallum' sp[ecies]", but later corrected himself, stating, "Either they are all conspecific or this is put as close to the Wallum sp. as to *H. propinqua s.str.*"; later again he added, "... but Wallum sp. has larger fl[owers] than *H. propinqua*". Ross (1986) recognised the distinctness of the "wallum species".

H. actites W.R. Barker, *sp. nov.*

H. gibbosa auct. non (Sm.)Cav.: F.M. Bailey, Qld Fl. 4 (1901) 1349; F.M. Bailey, Comp. Cat. Qld Pl. (1913) 454.

H. sp. aff. *propinqua*: Beadle, Stud. Fl. North Eastern N. S. Wales (1972) 247, p.p. (as to Coast plants).

H. sp. *A*: S.W.L. Jacobs & Pickard, Pl. N. S. Wales (1981) 180, p.p. (as to North Coast, NSW, and some Qld occurrences).

Hakea sp. *2*: E.M. Ross in T.D. Stanley & E.M. Ross, Fl. S. E. Qld, 2 (1986) 22.

In fruticeta oraria orientalia incolens, speciebus Sectionis *Hakeae* floribus albis, foliis teretibus, perianthiis glabris, rachidibus brevibus pistillis brevibus affinis; *H. sericea* pedicellis appresso-sericeis, cornibus brevioribus, formaque differente fructuum differt, *H. lissosperma* tomento ferrugineo in ramulis juvenibus, pistillis brevioribus, rostris conspicuis magis obliquioribusque, et aliis seminum longe decurrentibus.

Holotypus: W.R. Barker 5626 & I.R. Telford, E.M. Ballingall & D. Catling, 9.ix.1988, New South Wales, North Coast region, Northern boundary of Angourie, c. 1 km N of town centre by main road. Common; low sclerophyllous heath dominated by *Hakea* sp. (*W.R. Barker 5626*), *Banksia paludosa*, *Casuarina* sp., with emergent *Melaleuca quinquenervia* and *Banksia integrifolia*; shallow sand on clay on sandstone. Shrubs to 1 m, to c. 1½ m diam. in sheltered deeper sandy sites; base of stem swollen, one horizontal lignotuber seen; flowers cream-white, style-end pink from initial white; fruits remaining closed except on the many dying branches; single specimen per plant collected. AD99604180. *Isotypi*: 4 to be distributed.

Shrub, rarely small tree, 0.3–5 m tall, lignotuberous; branchlets densely pale lenticellate from an early age, multiribbed through a single rib long-decurrent from each leaf, but at length lacking ribs, covered by dense woolly tomentose to appressed sericeous indumentum glabrescent by or persisting after flowering, not glaucous. *Leaves* narrowly divergent from branchlets, directed obliquely upwards, (3.5)5.5–10.5(13.5) cm long, 0.8–1.3 mm broad, flexible to almost rigid, on most plants, though sporadically, with a single groove below at the very base, moderately to densely appressed-pubescent to appressed-sericeous, quickly glabrescent, not glaucous, porrect, with mucro (0.8)0.9–1.4(2.2) mm long, with a marginal vein along each side. *Inflorescences* axillary umbels; inflorescence-subtending bracts 0.6–2.0 mm long forming an involucre 1.1–2.6 mm long, dark brown, pale yellow distally, moderately to densely tomentose, confined to distal third on outer bracts, more extensive within, ciliate to ciliolate, not glaucous; rachis with vegetative shoots at base and (*Pedley 444*) distal of the flowering region; *flowers* 1–6, not subtended by minute bracts, on knob-like to elongated rachis developing immediately from the leaf axis, persistent, becoming woody but hardly enlarging, simple, 0.6–1.5 mm long, 0.4–0.5 mm diameter, persistently densely woolly tomentose with rust-brown hairs, with a single vegetative bud at base to halfway along; *pedicels* 1.8–3.0 mm long, sparsely to densely appressed-sericeous with hair arms slightly raised, with white and rust-brown hairs; *torus* oblique; *perianth* 3.1–4.3 mm long to summit of limb, white, ± cylindrical, recurved behind limb, glabrous, sometimes glaucous, splitting fully into tepals which are displaced to gland side of flower, the limb in bud ovoid or broadly so and (*Barker 5602*) green; *anthers* 0.4–0.55 mm long; *gland* hidden by basally erect tepals, a small V shaped flat to slightly curved flap with hollowed apex, 0.2–0.4 mm high, 0.1–0.25 mm long laterally; *pistil* vertically inserted, 6.7–8 mm long straightened, the ovary vertically inserted on obscure gynophore, with prominent horns, the style many times longer than the obscure gynophore, vertically inserted on ovary, recurved (often looped or tortuous), white turning pink-red (*Barker 5602, 5626*) the pollen presenter

oblique, 0.6–0.8 mm long medianally, surmounted by a central or displaced cone 0.2–0.5 mm high, topped by an apiculum 0.1–0.3 mm long. *Fruits* 1(2) borne on branchlets substantially thicker than other branchlets of same age, terminal on a short stalk, rarely (*Epps 41* with 2 fruits) derived on a very short peduncle; stalk separated by an articulation and narrowly divergent from the rachis, straight, derived from the pedicel and gynophore; *body* 2.2–3.4 cm long (those less than 2.5 cm long probably immature, but opening after collection), not to slightly compressed medianally, smooth and minutely lenticellate to moderately to coarsely pustulate, sometimes with crests of pustules rupturing, in median view transversely elliptic to broadly ovate to obovate, abruptly attenuate, apically obtuse; beak transverse to oblique, long-decurrent down more than half of one side of body, obliquely, very narrowly obovate, moderately large, with surface smooth, minutely lenticellate, with horns present but obscure, 0.5–1.5 mm long, well below apex of beak, with apiculum present but obscure; *valves* ovate to obliquely obovate or obliquely ovate, sometimes with a slightly curved to displaced apex, with a long attenuate base when mature, 1.6–2.5 cm wide, 2–2.5 times width of the pale wood zone; seed cavity ± porrect, close to the valve margin through the narrowness of the red-brown wood zone (1.5)2–5 mm wide by the base of the seed cavity; pale wood zone on the other side of the seed 0.4–0.5 times the width of the valve, 2-layered. *Seed* oblique, ovate to obovate, 1.6–2.5 cm long, (0.8)0.9–1.1 cm wide; *body* elliptic to obovate, 6.0–9.0 mm long, finely rugose to coarsely tuberculate; distal ridge absent; *wing* extending fully down both sides of body, more broadly on one side, black, dark blackish-brown, sometimes with small to large, pale to mid yellow patches. *Local name*: Mulloway needle bush (Arrawarra: *Foreman 964*). (Fig. 1, I–J).

Distribution (Map 2) *and ecology*: In near coastal regions of south-east Queensland and northern New South Wales. It is recorded as common to rare, on sandy soil or sand on clay, on swampy low-lying or higher ground, in "wallum" scrub or open heath, *Melaleuca* swamp forest, sedge swamp, *Eucalyptus* forest, or *Eucalyptus planchoniana* woodland.

Notes

1. The species has very distinctive smooth walled fruits with a smooth long decurrent beak with horns displaced well down from the fruit apex. It is allied to the cream-flowered terete-leaved species of Sect. *Hakea* with glabrous perianths, short rachises and short pistils (less than 9 mm long); from *H. sericea* it differs by its appressed-sericeous pedicels, its shorter horns, and its different fruit shape, from *H. lissosperma* by its ferruginous tomentum on the young branchlets, its shorter pedicels, its shorter pistil, its more prominent and oblique beak, and the long decurrent seed wing.

2. The epithet is a substantive, from the Greek *aktites*, coast-dweller, alluding to the coastal regions occupied by the species.

Additional selected specimens examined (85 seen):

QUEENSLAND. ***Moreton***: *D. Anderson s.n.*, 14.vii.1964, 4 m N of Caloundra, BRI 57128. – *W.R. Barker 5602*, 3.ix.1988, Summit of Mt Coolum on seaward upper slopes, AD. –*R. Coveny 6708 & P. Hind s.n.*,26.viii.1975, King John Creek on Bruce H/way, c. 12 km S of Beerburrum, BRI, NSW –*L. Durrington 212*, 27.iii.1973, Moreton Island, BRI. –*L. Pedley 444*, 19.viii.1959, Near Southport, on roadside in *Melaleuca quinquenerva* forest, BRI. –*L.S. Smith & D.J. McGillivray 3072*, 16.v.1968, 1 m N of Beerwah, NSW, AD. –*J.E. Young s.n.*,ix.1920, Bribie Is., BRI 281388. – ***Wide Bay***: *S.T. Blake 22063A*, 9.viii.1963, Near Cherwell River between Childers and Howard, BRI. –*F.C. Epps 41, 13329*, x.1921, Fraser Island, Wide Bay, BRI, AD. –*D.A. Goy & L.S. Smith 563A*, 28.xii.1938, Near Elliott River, near Bundaberg, BRI. –*I.R. Telford 4303*, 25.vii.1976, Upper Noosa River, 19 km N of Tewantin, CBG, AD. –*D. & V. Webb s.n.*, 20.x.1962, Gympie-Tin Can Bay Rd, between Kangaroo Creek to P.O. Tin Can Creek, NSW 58164. –*K. Williams s.n.*, 4.ix.1970, Cooloola on the roadside from Mt Bilewilan to Eight Mile Rocks, Rainbow Beach, BRI 103208.

NEW SOUTH WALES. ***North Coast***: *D.B. Foreman 964*, 24.viii.1985, Arrawarra, c. 6 km N of Woolgoolga, MEL, AD. –*D.J. McGillivray 2219*, 2.vii.1966, 1 m NW of Broomes Head, on the coast SE of Maclean, NSW, AD. –*J.B. Williams s.n.*, 6.viii.1967, Near Halfway Creek, S of Grafton, NE 25575.

H. macrorrhyncha W.R. Barker, *sp. nov.*

H. sp. aff. *propinqua* Cunn.: Beadle, Stud. Fl. North Eastern N. S. Wales (1972) 247, p.p. (as to Tablelands plants); W.J.F. MacDonald et al., Fl. Girraween & Bald Rock Nat. Parks (1995) 22.

H. sp. *A* (aff. *propinqua*): S.W.L. Jacobs & Pickard, Pl. N. S. Wales (1981) 180, p.p. (as to N. Tableland, NSW, and some Qld occurrences).

Foliis infra sulcatis, perianthiis tomentosis cremeis inter species Sect. *Hakeae H. macreanae, H. constablei* et *H. gibbosae* affiniore, omnibus rostrato multo longiore differt, etiam *H. macreana* mucronibus foliorum brevioribus, pedicello perianthioque tomentoso , et cornibus obsoletioribus, *H. constablei* floribus paucioribus in rachidi breviore, pedicello perianthioque tomentoso, pistillo breviore, et fructibus minoribus, et *H. gibbosa* in ramulis foliisque indumento breviore, foliis cito glabrescentibus et mucrone breviore, rachidi breviore, perianthio pistilloque breviore albo, et semine in fructu plus minusve stricto.

Holotypus: W.R. Barker 5611 & I.R. Telford, 7.ix.1988, Queensland, Darling Downs region: Girraween National Park, c. 3 km E of Ranger Station at Castle Rock camping area, SW of Dr Roberts Waterhole; locally abundant; granite hill with *Eucalyptus andrewsii, E. bancroftii, Callitris endlicheri* low closed woodland over *Exocarpos cupressiformis, Phebalium rotundifolium, Acacia adunca, Bossiaea* spp.; in rock crevices with deepish soil or in shallow gullies on sides of granite; erect tree to 6 m high, with single stem forked usually close to base; bark smooth, lenticellate, grey with ashwhite horizontal bands; branches ascending, young axes and leaf bases deep pink-red; pedicels deep pink with white hairs; tepals creamy white; style end pink-red even in mature bud; style reddening after anthesis; fruits remaining closed on plant for many years, opened on dead plants or branches; single specimen per plant collected, AD. *Isotypi:* CBG and many other duplicates to be distributed.

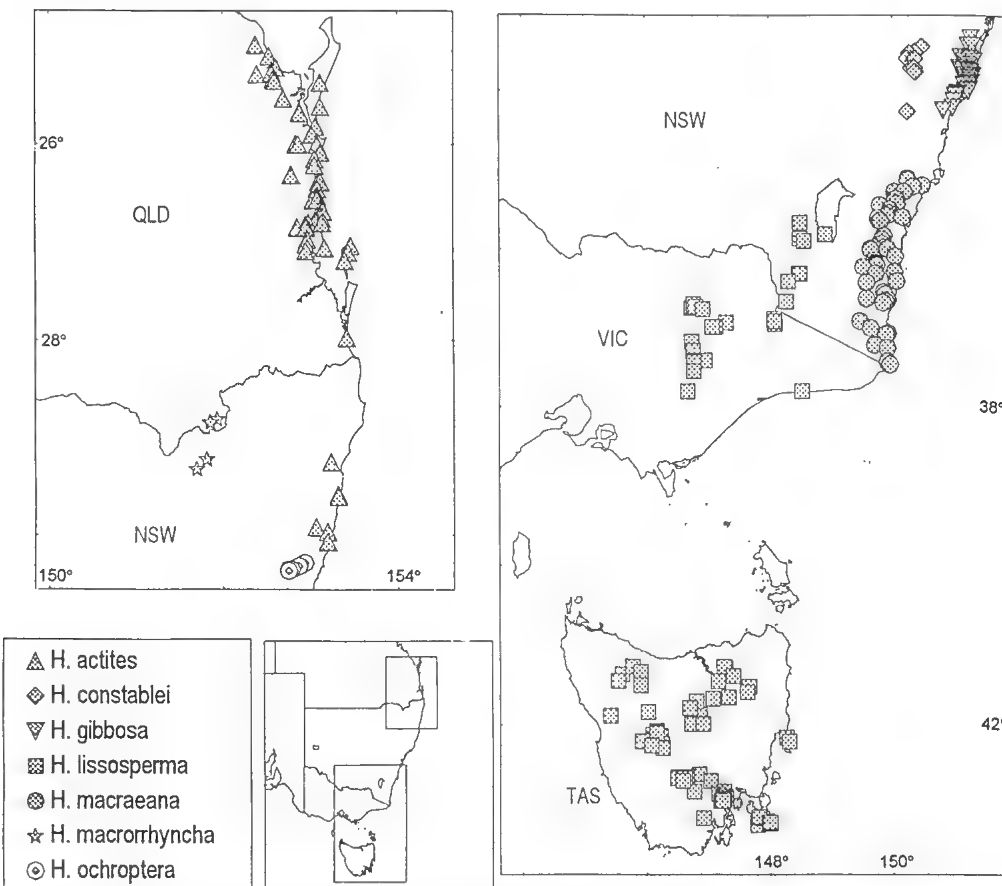
Erect shrub or small tree 1.8–6 m high, single-stemmed, though forked usually close to base (*Barker 5611*), lignotuber presence unknown; bark (*Barker 5611*) smooth, lenticellate, grey with ash-white horizontal bands; branches ascending; branchlets with rib decurrent shortly from each leaf base, otherwise smooth, deep pink-red becoming grey, when young densely white tomentose, the tomentum persisting over many nodes to flowering ones, becoming grey. *Leaves* simple, terete, narrowly angled to branchlets, (3)4.5–9 cm long, 0.9–1.5 mm wide, often with shallow longitudinal groove below from base for part or much of length, initially white tomentose, quickly glabrescent to expose smooth surface; base deep pink-red (*Barker 5611*), with no sharp flange like *H. propinqua*; apex porrect, the mucro 0.8–1.5 mm long. *Inflorescences* axillary umbels; inflorescence-subtending bracts caducous, white- woolly-pubescent all over; rachis knob-like, 0.5–0.7 mm long, simple, for most part knob-like (where bracts borne), white- woolly-pubescent; flowers c. 3–5; *pedicels* 4–5.5 mm long, deep pink, moderately densely white- raised-pubescent; *torus* oblique; *perianth* 3–3.8 mm long to the recurved apex, cream-white, externally moderately to densely white- raised-pubescent, splitting fully into 4 tepals; *anthers* 0.4 mm long with mid yellow pollen; *gland* a small U-shaped flap, 0.2 mm high, 0.15–0.2 mm wide laterally, with upper margin with a few teeth; *pistil* recurved, 6.5–8 mm long, the style white, reddening after anthesis, the pollen-presenter pink-red even in mature bud, obliquely conico-discoid, 0.15–0.3 mm high, 0.4–0.7 mm wide laterally, (topped by a)slender apiculum 0.1–0.2 mm long (bearing the stigma at the apex). *Fruit* long persisting closed; body medianally circular, laterally broad ovate, rugose-reticulate, the beak long, triangular, smooth but for dense small round blisters, decurrent down the red-brown wood side for much of the body length, very shortly so on the other; stalk with 3 parts, 10–12 mm long, smooth but for round blisters similar to beak on distal part; apiculum absent up to 0.1 mm long; horns obscure (by wear ?), up to 0.05 mm long, forming a truncate apex in median view; *valve* ovate, 3.5–4.5 cm long excluding stalk, 2.1–2.5(3.0) cm wide, acuminate by concavity on (white wood) side; seed cavity ± porrect; the red-brown wood zone dilated from halfway down length of seed, 3–4 mm wide, 0.35–0.5 times width of pale wood zone; pale wood zone 8–10 mm wide, 3-layered, the inner two layers ± equal, sometimes poorly distinct, together 4.5–18 times the width of the narrow outermost layer which is terminated ± ½–⅔-way to the apex of the valve. *Seed* elliptic-oblong, concave at apex of seed body, 3.0–3.4 cm long, 0.9–1.3 cm wide, black throughout; *body* obovate, 10–14 mm long, 6–9 mm wide, densely longitudinally rugose to rugose-reticulate, the ridges low, only slightly broken up, to partially muricate; distal ridge absent; *wing* decurrent down one side of body only for ¾ of distance.

Distribution (Map 2) *and ecology*: Restricted to the Torrington area of the Northern Tablelands of New South Wales and nearby to the Girraween National Park and environs in south-eastern Queensland. It is very localised, in hilly granitic areas of layered open forest or low closed woodland, associated with granite rock outcrops. Flowers (2 records): August–September.

Proposed conservation status: 2RC. McDonald et al. (1995) gave the species a status of 3RC, but the it is more restricted in distribution falling within an area less than 50 × 25 km .

Notes

1. By its leaves grooved below and tomentose cream perianths apparently most closely allied amongst the species of *Hakea* Sect. *Hakea* to *H. macraeana*, *H. constablei*, and *H. gibbosa*, it differs from all by its much longer beak; also from *H. macraeana* by its shorter leaf mucros, its tomentose pedicel and perianth, and its more obscure horns, from *H. constablei* by its fewer flowers on a shorter rachis, its tomentose pedicel and perianth, its shorter pistil, and its smaller fruits, and from *H. gibbosa* by the shorter indumentum on the branchlets and leaves, leaves quickly glabrescent and with usually shorter mucro, shorter rachis, shorter white perianth and pistil, and its seed more or less straight in the fruit.



Map 2. Distribution of the "*H. sericea* group", 2. ***H. lissosperma, H. actites, H. macrorrhyncha, H. constablei, H. macraeana, H. ochroptera***, and ***H. gibbosa*** in Australia.

2. The epithet is adjectival, derived from the Greek *macros*, long, and *rhynchos*, nose, referring to the long-beaked fruit of the species.

Additional specimens examined:

NEW SOUTH WALES. ***Northern Tablelands***: *J.L. Boorman s.n.*, i.1916, Torrington, SYD, NSW 182514, BRI 259676. –*H.J. Wissmann s.n.*, 5.xi.1969, Blatherarm Creek, 6 miles NE of Torrington, NE 029878.

QUEENSLAND. ***Darling Downs***: *J. James s.n.*, vi.[19]72, Girraween National Park, "Girraween" 1593. –*W.J.F. McDonald 278*, 27.viii.1974, Northern side of Girraween N[ational] P[ark], BRI 223799. –*K.N. Shea S120*, 22.x.1962, On property of W. McDonagh, Lyra, BRI 035163

A new location of *H. constablei* L. Johnson

A new location of *H. constablei* over 80 km south of its previously known range in the Mt Wilson - Mt Banks area has been discovered recently (Map 2; Moore 1993: *Kennedy 446*). The population stretches over about 3 km of sandstone escarpment in a similar habitat to that previously known. Dr L. Johnson (pers. comm. 1994) considers that there are intervening unsearched rugged tracts of sandstone country which should be searched for further occurrences of this species.

Selected specimens examined (35 seen):

NEW SOUTH WALES. ***Central Tablelands***: *W.R. Barker 5669*, 19.ix.1988, Du Faurs Rocks, Blue Mtns Nat. Park, AD. – *W.R. Barker 5674*, 19.ix.1988, C. 3.5 km by road S of Mount Wilson Fire Station on the main road to Bell, AD. – *C. Burgess s.n.*, 26.x.1962, King's Tableland (Blue Mountains), CBG 11573. – *E.F. Constable s.n.*, 6.x.1950, Bowen's Creek, Bilpin-Mt Irvine road, NSW 16415, MEL 108114, PERTH, K. – *E.C. Chisholm s.n.*, i.1923, Katoomba, NSW 54035. – *L. Johnson s.n.*, 10.viii.1953, Du Faur's Rocks, Mt Wilson, NSW 54034 AD 98714087. – *L. Johnson & T. Clifford s.n.*, 24.viii.1952, 1.5 m S of Bell (old mineshaft c. 200 yds. W of road), NSW 20279, AD 98714085, MEL 1537523. – *L.A.S. Johnson 8625 & D.H. Benson* , 8.x.1982, Kings Tableland near Mt Kedumba, 9 km S of Wentworth Falls, NSW. – *L.A.S. Johnson 7235 & A.N. Rodd*, 20.vii.1971, Mt Banks, Blue Mountains, NSW. – *M. Kennedy 446, A. Fairley, P. Moore & B. Michie*, 6.x.1992, C. 4 km N of "Ben Hur" property, Wanganderry Road, off Wombeyan Caves Road, walking towards Bonnum Pic, Nattai Nat. Pk, NSW. – *H.S McKee. 2*, 20.ix.1952, Near Bell, SYD. –*P. Harper s.n.*, 4.x.1964, Blackheath, SYD. – *J.H. Maiden s.n.*, x.1899, Mt Wilson, NSW 54032, AD 98714084, BM, B.

A new northern New South Wales species allied to *H. macraeana*

H. macraeana of the mountains of south-eastern New South Wales has a new counterpart in a group of ranges east of Dorrigo, in north-eastern New South Wales.

H. ochroptera W.R. Barker, *sp. nov.*

H. macraeana auct. non F. Muell.: G.J. Harden, Fl. N. S. Wales 2 (1991) 61 (note by W.R. Barker discerning northern and southern NSW populations).

Inter species Sect. *Hakeae* foliis longis flexilibus, a ramulis anguste divergentibus, infra per longitudinem maximam caniculatis, mucronibus longis, et fructu pustullis dispersis in corpus cetera laeve rostroque parvo transverso *H. macraeanae* affinis, sed ramulis juvenibus tomentosis, perianthio glabro, fructu cornibus obsoletis, semineque pallidiore differt.

Holotypus: *W.R. Barker 5636 & I.R. Telford*, 10.ix.1988, C. 1.2 km by road from and c. 250 m direct N of the summit of Mt Moombil, North Coast region, New South Wales. Scattered; tall closed forest on metamorphics. Tree c. 12 m high, with single stem c. 20 cm diameter at breast height and mid brown rough bark with vertical fissures; no lignotuber apparent. Branches ascending to spreading; when young mid brown, shiny. Leaves flexile, ascending. All flower parts pure white except mid green limb in bud; pollen light yellow-brown. Fruits remaining closed, opened only occasionally. AD99603477. *Isotypi*: several to be distributed.

Small tree or large shrub to 12 m high, lignotuber apparently absent (*Barker 5636*); branchlets with 1 rib decurrent from each leaf base, when young densely tomentose with some hairs appressed, persistent at least until flowering, not glaucous. *Leaves* simple, terete, narrowly divergent from branchlets, 5–13.5 cm long, 0.75–1.1 mm wide, flexible, with a shallow longitudinal groove below for most of length, initially moderately appressed-pubescent or sericeous, quickly glabrescent, not glaucous; apex straight, the mucro (1.1)1.5–2.0(2.2) mm long. *Inflorescences* an axillary umbel; inflorescence-subtending

bracts caducous, moderately to densely appressed-pubescent or -sericeous, all over on outer ones, ciliolate; rachis obscure, 0.5–1.2 mm long, densely, very shortly woolly, rust-brown tomentose; flowers 1–6; *pedicels* 4.5–7.5 mm long, sparsely appressed-sericeous with white hairs, not glaucous; *torus* oblique with gland on lower side; *perianth* c. 4.2–5.0 mm long to the recurved apex, white, glabrous, not glaucous, in bud with limb mid green, splitting into 4 free tepals; *anthers* c. 0.5 mm long with light yellow-brown pollen; *gland* a small flat to slightly curved broadly shallowly emarginate flap, c 0.25–0.3 mm high; *pistil* sigmoid to straight at base and recurved, c. 9.5 mm long (straightened), white, ` the pollen-presenter an oblique cone or disc raised centrally, 0.9 mm long, 0.2–0.4 mm high, laterally, sometimes topped by a filiform apiculum to 0.2 mm long. *Fruit* long closed; body medianally obliquely elliptic, 3.2–4 cm long excluding stalk, coarsely black- or white-pusticulate on blackish to grey bark; beak transverse, short, triangular, sometimes acuminate, not decurrent; stalk with 2 parts, c. 10–15 mm long; apiculum obscure, 0–0.05 mm long; horns obscure, 0–0.05 mm long, forming a ± truncate apex in median view; *valve* obliquely elliptic, 2.1–2.3 cm wide, seed cavity ± porrect; red-brown wood zone c. 4–4.5 mm wide; pale wood zone c. 8–10 mm wide, 2 possibly 3 layered, the outer very narrow, c. 1.5–3 mm wide, terminating c. 0.75–0.83 way along fruit. *Seed* obliquely obovate to narrowly so , 2.3–3.1 cm long, 0.55–0.9 cm wide; *body* obliquely narrow-obovate, 10–15 mm long, coarsely rugose to coarsely tuberculate; distal ridge absent; *wing* decurrent c. 0.5–0.75 way down one side of the body, fully down the other, light brown to off-white or hyaline, with light brown to light yellow streaks.

Distribution (Map 2) *and ecology*: Restricted to the east margin of the New England plateau, east of Dorrigo. It is known from about 12 locations, mainly in an area including the Dorrigo National Park known as the Bellingen escarpment on the Dorrigo plateau, but also to the east in the Nymboida River gorge just downstream from the confluence with Wild Cattle Creek and on Urumbilum River, a tributary of the Orara River (Mr A.G. Floyd, pers. comm. 18.x.1987; *Floyd 2160*). It is recorded as common on hillsides; on skeletal soil between rock sheets; or on rock ridge, in yellow earth, in light brush or depauperate warm temperate rainforest.. Altitude 150 m (*Floyd 2161*) to 1020 m (*Floyd 2160*).

Conservation status: 2RC. Areas of occurrence are reserved as National Park or State Forest.

Notes

1. Within Sect. *Hakea H. ochroptera* is allied to *H. macraeana* and *H. macrorrhyncha* by its long flexile leaves, narrowly divergent from the branchlets, grooved along most of the lower side, and with long mucros. It is closest to *Hakea macraeana* (Fig. 1, K–N) by its fruit with scattered pustules on an otherwise smooth body and with a small transverse beak, but differs from it by its tomentose young branchlets, its glabrous perianth, its fruits with obscure horns, and its lighter coloured seed.

2. The epithet is adjectival and derives from the Greek, *ochros*, yellow, and *pteron*, wing, alluding to an important diagnostic difference from *H. macraeana.*

Additional specimens examined:

NEW SOUTH WALES. *North Coast*: *W.R. Barker 5633*, 10.ix.1988, Cultivated in A. Floyd's garden, Coffs Harbour; originally from Urumbilum River, c. 2.5 km SSW of Dairyville, AD. – *W.R. Barker 5634*, 10.x.1988, C. 100m by road SE of summit of Mt Moombil, AD. – *A.G. Floyd 964*, 30.v..1978, 1 km NW of Dibbs Head, Dorrigo N.P., NSW, NE. – *A.G. Floyd 1092*, 17.x.1978, Summit of Dome Mtn, Dorrigo N.P., NSW. – *A.G. Floyd 2160*, 2.x.1987, N upper slope of Mt Moombil, AD (many duplicates for distribution) – *A.G. Floyd 2161*, 3.x.1987, Cultivated in collector's garden at Coffs Harbour. Parent from Urumbilum River, W of Coffs Harbour, AD (duplicates for distribution) – *W. Owen s.n.*, ix.1945, The Dome, Dorrigo, NSW190763. – *L.J. Webb & J.G Tracey 13628*, iii.1973, Mt Moonbill-Dorrigo plateau, BRI, AD. – *C.T. White 7491*, 4.x.1930, Dorrigo State Forest, BRI.

The *H. sericea* Schrad. & J.C. Wendl.–*H. decurrens* R. Br. complex

H. sericea has been long conceived as a wide-ranging species of south-eastern Australia, distributed from the northern coastal New South Wales to Victoria and Tasmania, with naturalised occurrences overseas, e.g. in South Africa, New Zealand and south-west Europe, while *H. decurrens*, when recognised as distinct, has been considered to be confined to the western slopes of the Great Dividing Range in New South Wales. Burbidge (1970) recognised only *H. sericea*, apparently as covering the two species, but alluded to the existence of a species complex in which the Australian Capital Territory form might be distinct. Beadle (1972) considered that *H. sericea* and *H. decurrens* intergraded.

In more recent times, the naturalised range of *H. sericea* has been extended eastwards to South Australia with the recognition of the synonymy of *H. vittata* var. *subglabriflora* with this species as then constituted (W.R. Barker 1985, 1986).

Examination of material pertaining to the two species indicated that the only character distinguishing the traditional *H. decurrens* from *H. sericea* is its thin fruits (owing to lesser development of the outer layer of the pale wood zone in each valve), utilised by Brown (1830) when he described the former; potential differences in branch indumentum and length of decurrence of the ribs below the leaf bases are bridged in the Victorian populations of *H. sericea*. On the other hand, collections from the eastern coastal strip of Australia between south-eastern Queensland and south-eastern New South Wales are quite distinct on flower size and indumentum, supported by characters of leaf flexibility and flower colour. As a result, the southern populations of *H. sericea* are transferred to an expanded *H. decurrens* which now comprises three geographical races.

South-east Queensland occurrences of true *H. sericea* are on Mt Barney, Mt Maroon and Mt Mee. Collections from these locations were recognised in recent times (Ross 1986) as distinct from other Queensland species, being considered to be possibly a more glabrous form of *H. gibbosa* (Sm.)Cav., a species confined to the Sydney region of New South Wales.

The taxonomy of *H. sericea s.lat.* presented here is supported by the results of investigations into a viable biological control programme commenced in the 1960s to combat this major invasive weed in South Africa (Kluge & Neser 1991). Because of climatic similarities with the South African sites, Wilsons Promontory in Victoria was originally chosen as a source for early insects of potential to diminish seed set and seedling establishment. Results were poor. These weevils had come from *H. decurrens* which has two subspecies on Wilsons Promontory. The South African plants are in fact true *H. sericea* which is confined to New South Wales. Kluge and Neser had noted morphological differences between Victorian and New South Wales plants, with the latter matching the South African plants. As a result plants from New South Wales provenances of the weevil were trialed with substantial success. Kluge attributed the success and failure of these weevil strains to differences in host plant compatibility.

H. decurrens R. Br., Suppl. Prod. Fl. Nov. Holl. (1830) 27.
Hakea tenuifolia var. *decurrens* (R. Br.) Domin, Biblioth. Bot. 89 (1921) 38.
Type citation: "Ora orient., mont. prope fl. Mac-Quarrie, 1818, *D. Fraser*."
Lectotypus hic designatus: *Fraser 41*, s.dat., Native in the Barren Lands in the Interior, height 5 foot/ Barren Lands of the Western Interior, Frutex 5 pedalis X[Oxley] 2nd Expedition (BMp.p.). *Other syntype*: *[Fraser] 46*, s.dat., Without locality (BMp.p.). *Possible isolectotype or isosyntype*: *C. Fraser s.n.*, 1818, Mount Tetley, Liverpool Plains, G-DC (?partly: upper specimen).

H. brachyrrhyncha F. Muell., First Gen. Report 17 (1853) *nomen nudum* (based on *Mueller MEL 675268, MEL 524086*); Meisn. in A.DC., Prod. 14 (1856) 401, *pro syn.*, under *H. acicularis* (as to *Mueller NY*).

H. acicularis R. Br. var. *lissosperma* auct. non (R. Br.)Benth.: Benth., Fl. Austral. 5 (1870) 515, p.p. (at least as to Wilson's Promontory and Stieglitz localities).

H. sericea auct non Schrad & J.C. Wendl.: Ewart, Fl. Vic. (1931) 407, p.p. (as to Tas. and most occurrences of var. *sericea*); Burbidge, Fl. Austral. Capital Terr. (1970) 146, p.p.; J.H. Willis, Hdbk Pl. Vic. 2. Dicot. (1973) 51, p.p. (excl. some NSW occurrences).

For further synonymy: see subspecies below.

Small trees or shrubs, 0.3–5 m tall, at least sometimes lignotuberous; branchlets with 1 rib decurrent from each leaf, when young sparsely to densely appressed-sericeous or tomentose, persistent or quickly glabrescent. *Leaves* widely spreading, as much a 90°, ± straight, 1.5–8 cm long, shorter at shoot apex, 0.7–1.6 mm wide, rigid, longitudinally grooved below, often to halfway, sometimes at base or almost to apex, glabrous or sparsely tomentose to appressed-sericeous and quickly glabrescent, porrect with mucro 1.0–3.5 mm long. *Inflorescence* an axillary umbel forming in a cone-like involucre 1–3 mm long; inflorescence-subtending bracts 0.6–1.7 mm long, dark brown, glabrous to moderately appressed-pubescent or tomentose along midline, ciliolate; rachis single in axil, sometimes developing from old woody rachises of prior season, knob-like to slightly elongated, 0.5–2.2(2.8) mm long, densely tomentose or appressed-pubscent, with white and/or ferruginous hairs, sometimes supporting a single bud; flowers 1–6; *pedicels* 1.2–4.0(4.8) mm long, sparsely to moderately tomentose or appressed-sericeous, the hairs white, sometimes also ferruginous; *torus* oblique with gland on lower side; *perianth* 4.2–7.2 mm long, glabrous, white, cream-white, sometimes with a pink or mid-red limb, splitting into 4 tepals; *anthers* 0.4–0.7 mm long; *gland* small, U- or V-shaped, 0.3–0.5 mm high; *pistil* 8.5–12.2 mm long straightened, the style recurved, the pollen-presenter oblique, 0.6–1.1 mm long, with central cone 0.3–0.7 mm high. *Fruit* 1(?2) in axil, persisting closed, 1.8–3.5 cm long, ovate or elliptic to depressedly so, rarely obovate in median view, finely to coarsely rugose to rugose reticulate, with crests rupturing, or with fine or coarse pusticulate tubercles; beak small to moderately large, transverse to oblique, shortly to long decurrent down one side of fruit body, smooth or sparsely tuberculate, or finely to coarsely rugose-reticulate and fissured, or smooth; horns 1–5 mm long, often broken; stalk in 2 parts derived from pedicel and gynophore; *valves* obliquely narrowly to broadly ovate, 1.0–3 cm wide; seed cavity oblique relative to axis of fruit; pale wood zone 2-layered. *Seed* 17–23 mm long, 6.5 –10.5 mm wide; seed-body in outline obliquely elliptic or obovate to circular, 6–10 mm long, finely to coarsely, unevenly tuberculate and/or rugose, sometimes with fine longitudinal ridges, or rugose-reticulate,; wing completely encircling body, narrower down one side than other, usually dark blackish-brown, sometimes dark brown.

Distribution:

Refer to the subspecies for clarification.

The species occurs in Madeira, but which of the subspecies is present cannot be determined without seeing fruiting material.

Notes

Characters of the fruit vary on a geographical basis in this species, as newly constituted, resulting in the separation of three subspecies (Fig. 2, D–H). Inland plants on the western slopes of the Great Dividing Range in New South Wales are distinguished by the reduced amount of wood in the outer layer of the pale wood zone of each valve, resulting in the fruit body being much narrower in the median view than in most other needlewoods. These plants are referred to ssp. *decurrens*. The character should be examined in mature fruits, as this outer layer thickens as the fruits develop. Even thinner fruits are developed in other groups of *Hakea*, examples in Sect. *Hakea* being *H. nodosa* and *H. microcarpa* of eastern Australia and *H. recurva* of Western Australia. Plants found throughout much of Victoria and in adjacent far south-eastern New South Wales have a full-bodied fruit more typical of most species in the genus. These are referred to ssp. *physocarpa*. A second character is found in coastal sites of south-eastern Victoria. Here plants have a much thicker band of deep red-brown wood on the face of each open valve. These plants are referred to ssp.

platytaenia. Such thickening in the red-brown wood layer distinguishes taxa within unrelated groups of *Hakea*, e.g. *H. constablei* in Sect. *Hakea* and some members of the corkwoods (the *H. lorea* group: Blake 1963, W.R. Barker, in preparation).

Ssp. *physocarpa* extends into the scattered near-coastal locations occupied by ssp. *platytaenia*. However, population collections by Parris indicate that broadly banded red-brown wood zone in the fruits characterises plants at a specific site. It would be useful to make studies in these sites as to the degree of intergradation between the two taxa.

Typifications

H. decurrens R. Br.

The four branches on the lectotype sheet all belong to the one taxon but probably represent two collections since there is a separate label bearing the number *46* and the determination "H. acicularis ?". It is difficult to distinguish between two collections on the sheet; two of the branches have fruit and apparently come from the same source, the other two have flowers and also appear identical. Brown's annotations however refer only to *Fraser 41* and so only the bottom two branches of the sheet have been treated as the lectotype since the label with *41* on it is to be found closest to them. These two branches have flowers and fruits, both of which are described in the protologue. Presumably Brown saw all of the material on the sheet and so the upper two branches are syntype material. A case can be made (depending on interpretation of the ICBN) for considering the whole sheet to be the lectotype or even holotype (depending on the significance of the label bearing the number *46*), since there is no evidence that Brown saw any other material of this species.

Confusion has been caused in the typification of this species also by the further collection of this species by Allan Cunningham when he revisited the site on the Liverpool Plains in May 1825. All of the material in Cunningham's herbarium apparently represents his collections from that time, even though he also cites Fraser's 1818 collection from Mt Tetley. There is no evidence that Brown ever saw the Cunningham collections even though they were made before the protologue, and so they have not been treated as type material.

H. brachyrrhyncha F. Muell.

It is difficult, with only one specimen in fruit (*F. Muell., vii. 1853, K*: ssp. *physocarpa)*, to determine if Mueller's nomen nudum *H. brachyrrhyncha* was based on material of both ssp. *physocarpa* and ssp. *platytaenia*, the location on Wilsons Promontory possibly indicating the latter.

Specimens unable to be determined to subspecies level:

MADEIRA: *L.O. Franquinho 52*, xii.1970, Cultivated only in a few places in Madeira forming prickly hedges, BM. –*R. Hegnauer 11999*, 11.iv.1968, Madeira; tussen Camacha en Poiso, L.

NEW ZEALAND: *A.J. Healy s.n.*, 28.v.1950, Between Waipu Cove and Hakura, east coast, Nth. Auckland, CHR 70931.

Key to the subspecies of *H. decurrens*

1. Red-brown wood zone on inner face of fruit valve beside seed cavity at widest point towards base 1–2.5 mm wide. Indumentum on branchlets appressed, usually quickly glabrescent, sometimes persisting to flowering, to tomentose.
   2. Fruit in median view ovate to elliptic or broadly so, 1.5–3.6 mm wide; pale wood zone (4.5)6–12 mm wide, the outer layer 2.5–5.5 mm wide .... ssp. ***physocarpa*** (p. 192)
   2. Fruit in median view ovate to obovate, 1.4–1.9 mm wide; pale wood zone 3.5–6 mm wide, 2-layered, the outer layer 1–2.5(3) mm wide .... ssp. ***decurrens*** (p. 195)
1. Red-brown wood zone on inner face of fruit valve beside seed cavity at widest point towards base 3–5 mm wide. Indumentum on branchlets tomentose, persistent to well after flowering .... ssp. ***platytaenia*** (p. 196)

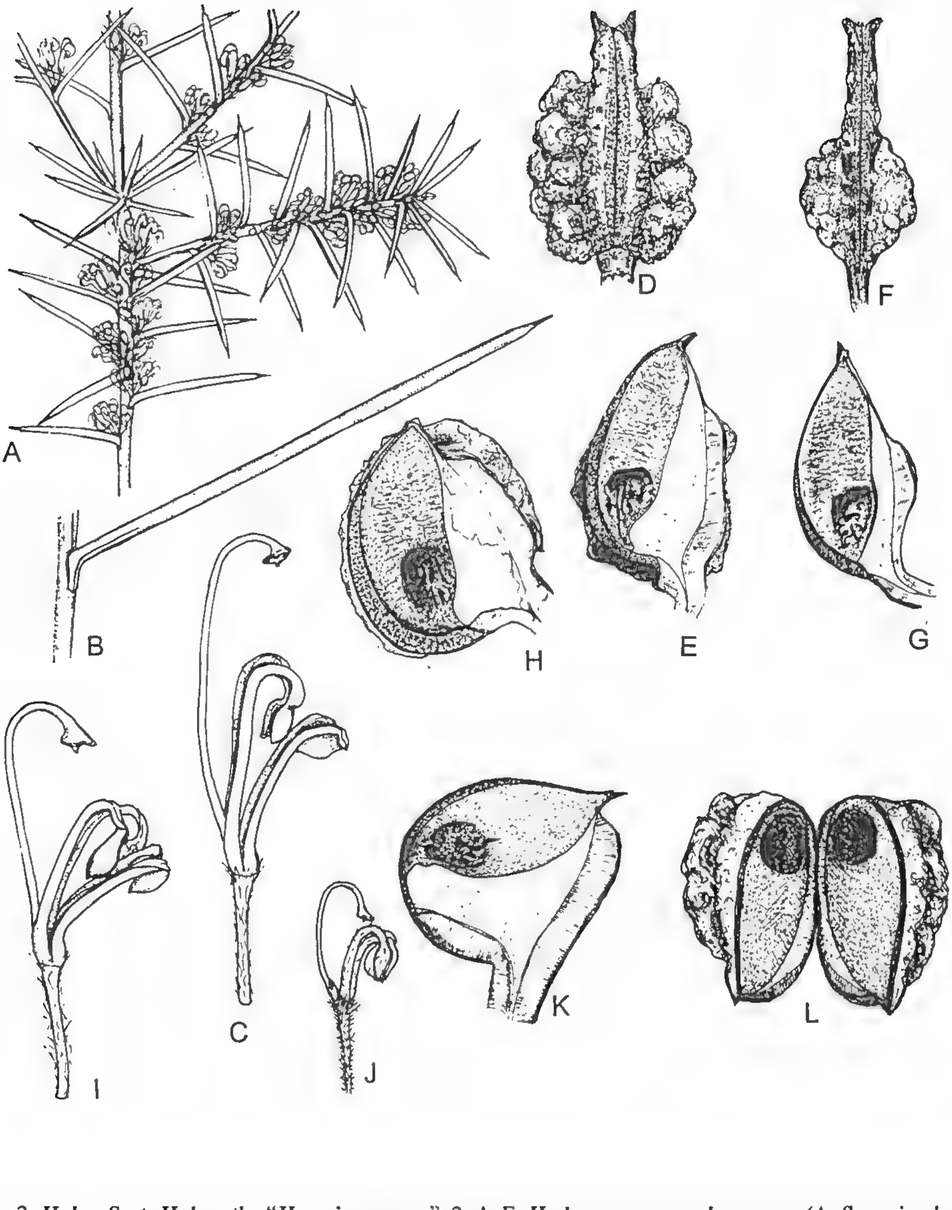


Fig. 2. ***Hakea*** Sect. ***Hakea***, the "***H. sericea*** group", 2. A–E, ***H. decurrens*** ssp. ***physocarpa*** (A, flowering branch ×0.75; B, leaf ×2; C, flower × 4.5; D, fruit ×1, E, valve, inner face ×1). F–G, ***H. decurrens*** ssp. ***decurrens*** (F, fruit ×1; G, valve, inner face ×1). H, ***H. decurrens*** ssp. ***platytaenia*** (valve, inner face ×1). I, ***H. sericea*** (flower ×4.5). J–L, ***H. gibbosa*** J, flower ×2; K, valve, inner face ×1; L, open fruit ×1). (A–C, *Beauglehole 28152*; D–E, *Beauglehole 30817*; F–G, *Constable 5026*; H, *Smith MEL1537502*; J, *Camfield NSW58167*; K–L, *Cleland AD97848283*). (Del. B. Chandler).

H. decurrens R. Br. ssp. **physocarpa** W.R. Barker, *ssp. nov.*

Ssp. *decurrente* fructibus lateraliter tumidis differt, et ssp. *platytaenia* taenia ligni angusta porphyrea in faciem interiorem valvae fructus et indumento in ramulis celerius glabrescentibus et appressioribus.

Holotypus: *A.C. Beauglehole 30817*, 23.iv.1969, Victoria, Grampians, Black Range, extreme N end, E side of Picnic Rocks; to several feet high in deep sand; flowers pink and on numerous plants; assoc. [plants]: *Thryptomene, Callitris, Banksia ornata, Hybanthus floribundus,* AD97931220. *Isotypus*: MEL542886.

Hakea longispina Gand., Bull. Soc. Bot. France 66 (1919) 229.
Type citation: "Victoria, Walter". *Holotype*: *C. Walter s.n.*, s.dat., Victoria, LY (McGillivray 1973: "1902" is date of receipt). *Probable isotype*: *C. Walter s.n.*, vi. 1896, Victoria, BR.

Hakea vittata R. Br. var. *glabriflora* J.M. Black ex J.H. Willis, Vic. Nat. 73 (1957) 150, p.p. (excluding *French MEL 643057* from Wimmera).–*H. vittata* R. Br. var. *glabriflora* J.M. Black, Fl. S. Austral, edn 2, 2 (1948) 265, *nom. inval.* (lacking Latin description).
Type citation: "Stirling East". *Holotype*: *J.B. Cleland s.n.*, Aug. 1944, Stirling East, AD 95643058. *Isotypes*: AD96807226 (*Possible isotypes: J.B. Cleland s.n.*, 19 Aug. 1944, near Stirling East School, MEL 664231, NSW.)

Hakea sp. aff. acicularis R. Br.: Maiden, Proc. Linn. Soc. N.S. Wales 28 (1904) 747.

Hakea sericea auct. non Schrad. & J.C. Wendl.: e.g., Ewart, Fl. Vict., (1931) 407, p.p., as to var. *sericea*; W.M. Curtis, Student's Fl. Tasmania 3 (1967) 610; W.R. Barker, J. Adelaide Bot. Gard. 7 (1985) 245, p.p., excluding NSW material; W.R. Sykes, Fl. N. Zeal. 4 (1988) 999, p.p.; P.W. Ball, Fl. Europ. 1 (1964) 65.

Small tree or shrub 0.8–5 m tall. *Branchlets* sparsely appressed-sericeous to densely tomentose, sometimes with some hairs appressed, quickly glabrescent to persistent to after flowering. *Leaves* when very young and flexible sparsely sericeous (e.g. *Phillips CBG 038852*), quickly glabrescent. *Pedicels* sparsely to densely, appressed-sericeous to almost tomentose, with few to many hair arms raised. *Fruit* in median view ovate to elliptic, or broadly so, 2.1–3.2 cm long, 1.5–3.6 cm wide, in lateral view 1.3–2.5 cm wide; *valve* with red-brown wood zone 1–2.5 mm wide; pale wood zone (4.5)6–12 mm wide, 2-layered, the outer layer 2.5–5.5 mm wide. (Fig. 2, A–E)

Distribution (Map 3) *& ecology*: In the Grampians, central and eastern Victoria, occurring in *Eucalyptus* forest, damp heath or dry scrubland in hilly areas on sand, clay, granite, basalt or sandstone, from sea level to 300 m. Flowering June–Sept.

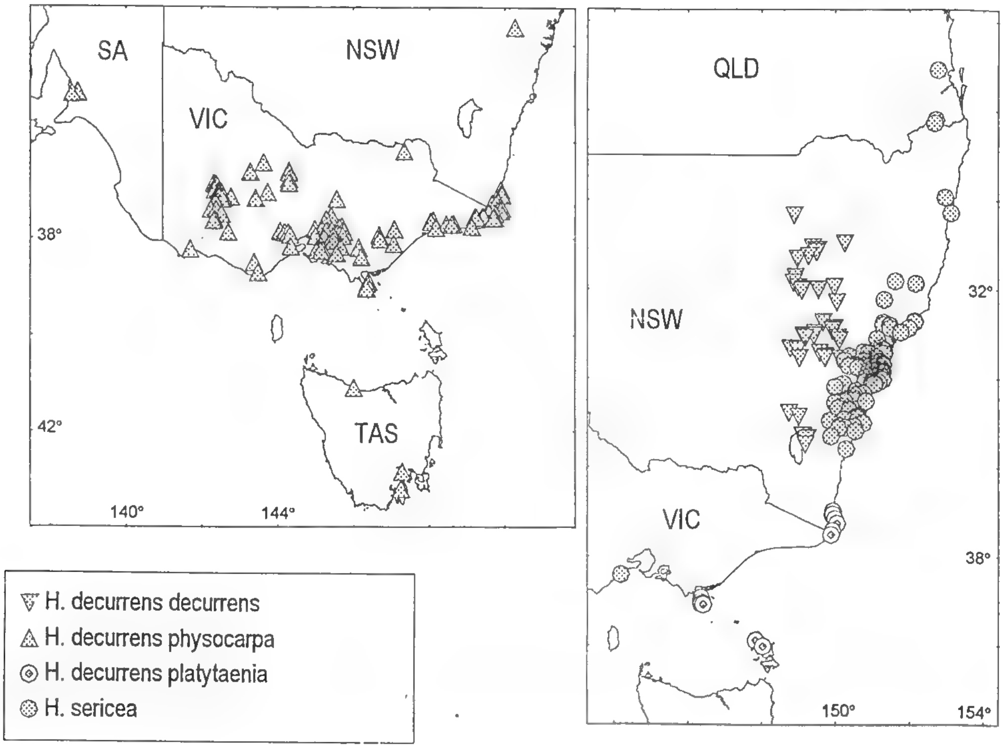
The species has been naturalised at least since the 1930s in the Mt Lofty Ranges, South Australia, having been in cultivation nearby by 1925 (W.R. Barker 1985). Occurences in the Blue Mountains, New South Wales, and in southern Tasmania near Hobart are likely to be adventive (see Note 1). It is also likely to be the plant known as *H. sericea* naturalised in Spain and Portugal (Ball 1964; *Orey et al. 56*).

Notes

1. Plants collected from Blackheath Golf Links in the Blue Mountains, and noted by New South Wales botanists as a "larger-flowered form" of *H. sericea*, are a probable introduction rather than a relictual stand forming the northernmost outpost of the subspecies. They have the full-bodied fruits of ssp. *physocarpa*. Like the populations in the Mt Lofty Ranges, South Australia (W.R. Barker 1985), these have probably originated as a garden escape, the taxon being commonly in cultivation (pers. observ.). The relatively recent collection of the plants support this, for the first of the three herbarium collections in NSW was made in 1947, despite the location being in an area visited from the earliest days of inland exploration and settlement of the Blue Mountains. Similarly, Tasmanian localities widely disjunct from the normal distributional and possibly climatic range of the species must be treated as doubtfully representing an indigenous occurrence, more likely being adventive or just cultivated.

2. The subspecies shows variation in branchlet indumentum and persistence, but this does not seem regionally correlated.

3. The epithet is adjectival and derives from the Greek *physa*, bellows, a swollen object, and *karpos*, fruit, refering to the broader more woody fruits which distinguish this plant from ssp. *decurrens.*



Map 3. Distribution of the "*H. sericea* group", 3. ***H. decurrens*** ssp. ***decurrens***, ***H. decurrens*** ssp. ***physocarpa***, ***H. decurrens*** ssp. ***platytaenia***, and ***H. sericea*** in Australia. Tasmanian occurrences of ***H. decurrens*** ssp. ***physocarpa*** are doubtfully indigenous.

Typification

H. longispina Gand.

The BR specimen is a good match for the LY type material and is probably an isotype. Another specimen annotated as a possible isotype (*Walter NSW112286*) is unlikely to have such status, differing in its shorter leaves, older flowers and smoother fruits.

Selected specimens examined (203 seen):

SOUTH AUSTRALIA. ***Southern Lofty***: *W.R. Barker 1894*, 29.v.1977, Watiparinga National Trust Reserve, Belair (a suburb of Adelaide), AD. –*R.T. Lange s.n.*, 12.vii.1961, A few miles N of Stirling, down slope from road junction signposted "Woodhouse Golf Links" (Stirling, c. 15 km SE of Adelaide), AD.

NEW SOUTH WALES. ***Central Tablelands***: *Mr Hand, per O.G. Vickery s.n.*, 16.ix.1947, Blackheath, NSW 4430. – *M. Tindale & E. Constable s.n.*, 27.iii.1952, Blackheath, Golf Club Grounds, NSW 19375. – ***South Coast***: *E.F. Constable 4399*, 19.viii.1963, Head of Nadgee River, Nadgee Faunal Reserve, 12 m E of Timbillica (Ca 22 m S ofEden), NSW. –*R. Coveny 2930*, 30.vii.1970, 16.1 km (10 m) N of Timbillica on the Princes H/way (ca 29 km [18 m] S of Eden), NSW, W. – *I.R. Telford 6819*, 28.x.1977, Wallagaraugh River-Imlay Creek junction, CBG. – *N.A. Wakefield 3637*, 1.x.1950, Bellbird Gully (a few miles from Eden and Twofold Bay), MEL.

VICTORIA. ***East Coastal Plains***: *A.C. Beauglehole 62086*, 4.xii.1978, 4 km NNE of Mirboo North, 24 km NE of Leongatha P.O., MEL. –*P.F. Lumley G20.1*, 17.xii.1979, Mallacoota, 2 km from Princes H/way on l.h.s. of the East Wingan Road, MEL. –*J. Rodway s.n.*, viii.1940, Mornington, Pt Phillip, NSW 97014. –*N.G. Walsh 180*, 14.viii.1979, Montas road 0.6 km S of Old Orbost road, 4.5 km S of Tostaree, MEL. – ***Eastern Highlands***: *A.C. Beauglehole 31817*, 17.xi.1969, Mallacoota Inlet National Park, Captain Creek area, c. 3 m direct NW of Mallacoota P.O., MEL. –*M.D. Crisp 7127*, 21.vii.1983, 6 km directly ENE of Gembrook, 4 km E along Black Snake Creek Road from Whites Corner, CBG, MEL. –*D.B. Foreman 1036*, 4.ix.1985, Torbet Road, 2 km from Gilderoy Road turnoff, 3 km W of Powelltown, MEL, AD. –*K.R. Thiele 367*, 1.viii.1982, Red Hill, just south of Cardinia Resevoir near Beaconsfield Upper, MEL. – ***West Coastal Plains***: *Anon.(Herb. F. Mueller) s.n.*, s.dat., Near Geelong, MEL 1536737. –*G.E. Earl 297 & D.M. Parkes s.n.*, 8.vi.1983, Otway Region; Pipeline Track, MEL. –*M.E. Phillips s.n.*, 15.ix.1961, Near Mt Clay, Portland, at Mr Fink's house, CBG 5572. – ***Western Highlands***: *L. Haegi 1453*, 25.ix.1977, C. 0.5 km NW of Golton Gorge turnoff on Halls Gap-Mt Zero road, AD, NSW. –*T.B. Muir 1206*, 22.viii.1960, The Grampians, Pomonal Road c. 1.5 m from Halls Gap, MEL, UPS. –*F. Robbins per A.C. Beauglehole 7974*, 1.xi.1931, Bendigo, Whipstick, MEL. –*R.V. Smith 59/225*, 25.ix.1959, Bordmans Track, c. 2 m W of Mt Anakie, Brisbane ranges, MEL, AD. – *(Rev.) J.B. Staer s.n.*, 1867, St Arnaud, MEL 1536731. – *C. Walter s.n.*, ix. 1898, Grampians, Victoria, NSW 112286. –***Wilsons Promontory***: *Anon. s.n.*, iv. 1853, on rocky declivities of Mount Hunter, MEL 1524086 – *Anon. s.n.*, s.dat., near Mount Hunter, MEL 675268 (Herb. Sonder). – *J. Galbraith s.n.*, x.1958, Mt Oberon, MEL 675420. – *Dr Ferd Mueller s.n.*, 1853, Near Mount Hunter, Australia felix, NY (partly, as to larger flowered piece: ex Herb. Sonder 1854).– *G.B. Stokes P.2*, 15.viii.[19]62, Tidal River, Wilsons Prom., MEL.

TASMANIA. ***Furneaux***: *L. Rodway s.n.*, i.1894, Flinders Island, HO 92467. –*M. Thompson 71*, 15.iii.1976, Flinders Island, HO. – ***North-West***: *L. Rodway s.n.*, ix.1915, Sulphur Creek, HO 20389. – ***East Coast***: *Anon. s.n.*, 23.ix.1945, Lenah Valley, HO 20390. – ***Questionable (East Coast)***: *W.M. Curtis s.n.*, viii.1948, Flowerpot (near Hobart: probably cultivated), HO 20391.

PORTUGAL: *E. Orey, D. Pereina & Reis 56*, 15.xi.1966, Lusitania. Reg. Estremadura, Estrada da Pimanceira, proximo de e Mafra, BR.

H. decurrens R. Br. ssp. decurrens

H. decurrens R. Br., Suppl. Prod. Fl. Nov. Holl. (1830) 27.
Hakea tenuifolia var. *decurrens* (R. Br.) Domin, Biblioth. Bot. 89 (1921) 38.

Semi-prostrate to erect, bushy to scrambling shrub, 0.4–2.4 m tall. *Branchlets* sparsely to densely appressed-pubescent or -sericeous,. *Leaves* sparsely to moderately appressed-sericeous, quickly glabrescent. *Pedicels* sparsely to moderately appressed-sericeous. *Fruit* in median view ovate to obovate, 1.8–3.0 cm long, 1.4–1.9 cm wide, in lateral view 1.0–1.8 cm wide; *valve* with red-brown layer 1.2-2 mm wide; pale wood zone 3.5–6 mm wide, 2-layered, the outer layer 1–2.5(3) mm wide. (Fig. 2, F–G).

Distribution (Map 3) *& ecology*: Occurs only in New South Wales throughout the western slopes and neighbouring tablelands regions. It occupies thick scrub to open *Eucalyptus* woodland or forest, often from hilly country, altitude 430–900 m. Flowers May–Sept., usually July

Note

The location Castlereagh, a town of the 1800s now a suburb of Sydney, attached to *Woolls MEL 1537893* is likely to be erroneous. No other record of this species occurs in the Sydney region. The nearest locations are in the central and western Blue Mountains. It is most likely either that the location pertains to the region of the Castlereagh River or that the label is misplaced. Ssp. *decurrens* is known from several locations in the vicinity of the upper Castlereagh River.

Selected specimens examined (75 seen):

NEW SOUTH WALES. ***North-Western Plains***: *N. Perry s.n.*, vi.1967, Pilliga scrub, NSW 190676. – ***North-Western Slopes***: *W.A.W. de Bengeville s.n.*, x.1915, Warrumbungles Mountains near Coonarabran, NSW 58236, AD 98714078. –*B.R. Paterson s.n.*, 11.viii.1958, 24 km (15 m) from Coonabarabran, on Narrabri Road, NE 13993. – ***Central Western Slopes***: *G.W. Althofer s.n.*, 6.xii.1944, Dubbo-Mendooran road, NSW 58234. –*N.D Anderson. s.n.*, 1.xii.1977, Adjacent to Womboin Plains Rd, c. 15 m SE from Gilgandra towards Mendooran, NSW 190677. –*R. Coveny 4189*, 16.iv.1972, The Mullions Range, 14 m (22.5 km) NNE of Orange, NSW, NT. – *L.A.S. Johnson s.n.*, 11.iv.1953, Dividing Range, 12 m N of Rylstone, NSW 58233, AD 98714079.– ***Central Tablelands***: *P. Aethofe s.n.*, ix.1951, Capertee to Glen Davis, NSW 58270. –*R. Lembit s.n.*,15.xi.1985, Near Wentworths Sugarloaf, Cox's River, NSW 191781. –*J. Pickard 487*, 23.x.1969, Little Bald Hill, c. 6 km N of Hill End on Hargraves-Hill End road, NSW. ***South-Western Slopes***: *C.W.E. Moore 3124*, 9.iii.1959, Site 21 NW

slope, Hume H/way 11.5 m from Yass, CANB. – ***Southern Tablelands***: *W.R. Barker 5681*, 21.ix.1988, Black Mountain, natural occurrence c. 100 m N of National Botanic Gardens administration buildings directly up slope, AD. –*E.M. Canning 2860*, 8.vi.1969, C. 8.4 m from Yass, toward Goulburn, along Hume H/way, CBG. –*M. Evans 2640*, 7.x.1967, Mt Jerrabombera, 2 m SW of Queanbeyan, CANB (2 sheets), AD. –*I.R. Telford 994*, 22.vii.1969, Molonglo Gorge, 3 km NE of Queanbeyan, CBG. – ***Location doubtful (Central Coast)***: *Woolls s.n.*, s.dat., Castlereagh, MEL 1537893. –

H. decurrens R. Br. ssp. platytaenia W.R. Barker, *ssp. nov.*

Subspeciebus duobus alteris *H. decurrentis* taenia ligni porphyrea in faciem interiorem valvae fructus latissima et indumento in ramulis persistentiore differt, etiam ssp. *decurrente* fructibus lignosissimis.

Holotypus: *M. Parris 9714*, 23.vii.1990, New South Wales, South Coast region, Ben Boyd National Park, AD99603472 (Plant H). *Isotypi*: AD99603473 (Plant F), CBG,and many others to be distributed. (Different letter suffixes following the collectors number represent different plants in the population).

Small, erect woody or stiff upright, shrub, rarely a small shrubby tree, 0.3–2 m tall. *Branchlets* moderately to densely tomentose, with some hairs appressed, rarely (partly *Crisp 459*) moderately appressed-sericeous, persistent to well after flowering (probably several seasons). *Leaves* glabrous, or sparsely tomentose with some hairs appressed and quickly glabrescent. *Fruit* in median view broad to depressed ovate to broad to transverse elliptic, 2.6–3.5 cm long, 2.6–3.6 cm wide; *valve* with red-brown wood zone 3–5 mm wide; pale wood zone 8–15 mm wide, 2-layered, the outer layer 3–5 mm wide. (Fig. 2H).

Distribution (Map 3) *& ecology*: Confined to near coastal regions of eastern Victoria from Wilsons Promontory eastwards into south-eastern New South Wales and on the Bass Strait Islands, in windswept heath. Flowers May–Sept.

Notes

The epithet is adjectival, from the Greek *platys*, broad, and *taenia*, ribbon, alluding to the broader red-brown layer of the fruit valve compared with the other subspecies.

Selected specimens examined (22 seen):

NEW SOUTH WALES. *South Coast*: *D.E. Albrecht 410*, 23.iv.1984, C. 0.3 km W by track from the Saltwater Creek camping ground, S of Eden, MEL 661931, AD 98443292. – *Anon.(Herb. F. Mueller) s.n.*, s.dat., Twofold Bay, MEL 1536726. –*R. Coveny 58076 & J. Armstrong s.n.*, 16.x.1974, Green Cape lighthouse, 26 km SE of Eden, NSW. –*L.A.S. Johnson s.n.*, 2.xii.1950, Eden, NSW 58212. –*E. Mullins 534*, 4.ix.1978, Ben Boyd National Park; ca 2 km along track S from camping area at Saltwater Creeek mouth, to Hegartys Bay, CBG 7807890. – *M. Parris 9587–9590*, 31 Aug 1989, Long Beach, near The Pinnacles, 7.5 km direct SE of Pambula, CBG, AD (each collectors number a different plant, the different letters appended referring to separate branches from the one plant; a number of duplicates of each number for distribution). –*M.E. Phillips s.n.*, 8.x.1961, Green Cape, CBG 6074. –*J. Pickard 1042*, 1.vi.1970, C. 2 m S of H.Q. on road, Nadgee Nature Reserve, NSW. –*J. Pulley 478, 479, 495*, 20.v.1970, Quoraburagum Point, South Coast, CBG.

VICTORIA. ***Eastern Highlands***: *Anon(Herb. F. Mueller) 132*, s.dat., Howe Hill, MEL 675448. – ***Wilsons Promontory***: *Audas & St John s.n.*, 10.xi.[19]08, Martins Hill, Wilsons Promontory, MEL 1524084. –*A. Meebold 2307*, i.1929, Wilsons Promontory, M. –*M.E. Phillips s.n.*, 21.xi.1961, Track to Lilly Pilly Gully, Wilsons Promontory, CBG 5560. –*P.K. Smith s.n.*, 10.vi.[19]65, Oberons foot, Wilsons Prom[ontory], MEL 1537502.

TASMANIA. ***Furneaux***: *B.C. Crisp 459*, 26.ii.1977, Flinders Is, summit of Mt Tanner, HO 28527 CBG 67560. – *R.C. Gunn 2000*, 30.viii.1845, Flinders Island & Cape Barren, NSW 58247, K. –*J. Milligan 643*, 30.viii.[18]44, Flinders Island, E, BM.

Hakea sericea Schrad. & J.C. Wendl., *Sert. Hannov.* 3 (1797) 27; Burbidge, Fl. Austral. Capital Terr. (1970) 146, p.p.

Type citation: no details given; presumably a plant grown in the Hannover Garden. *Syntypes*: not seen.

? Banksia tenuifolia Salisb., Prod. Stirp. Chap. Allerton (1796) 50.
H. tenuifolia (Salisb.) Britten, J. Bot. 54 (1916) .
H. tenuifolia (Salisb.) Britten var. *tenuifolia*: Domin, Biblioth. Bot. 89 (192) 592, p.p. (as to NSW locations), *nom. illeg.*, [non *H. tenuifolia* Dum.-Cours., Bot. Cult. 5 (1805) 107, *nomen sedis incertae*].
Type citation: "Ex Port Jackson auct. Jac. Lee". *Syntypes*: not seen.

Banksia pinifolia Salisb., Prod. Stirp. Chap. Allerton (1796) 51, nom. illeg. (*B. gibbosa* Sm. in synonymy).
H. pinifolia Knight & Salisb., Cult. Pl. Nat. Order Prot. (1809), 107, nom. illeg.

Conchium aciculare Donn., Hortus Cantabrig. 2nd edn (1800), *nomen nudum*; 3rd edn (1804) 21, *nomen nudum.*

Conchium aciculare Sm. ex Vent., *Jard. Malmaison* 111, t. 111 (1805), non Donn.
H. acicularis (Sm. ex Vent.) Knight & Salisb., Cult. Prot. (1809) 107.
B. acicularis (Vent.) J. Parm., Cat. Pl. Enghein (1818) 111.
Type citation: "Originaire de la Nouvell Hollande cultivé à la Malmaison de graines rapportées du voyage de Capt. Baudin.".
Holotype: *Anon. (Herb. Ventenat) s.n.*, s.dat. Malm[aison], G.

Conchium compressum Sm. in Rees, Cycl. 9 (1807) no.5.
H. acicularis var. *smithii* Endl., Gen. Pl. Suppl. 4(2) (1848) 85 (based on *C. compressum* Sm.).
Type citation: "Sm. MSS." ("Near Port Jackson, Dr White" in Smith, Trans. Linn. Soc. Lond. 9(1808) 121).
Syntypes: none seen (White specimens in herb. J.E. Smith lack fruits).

H. sericea var. *sericea*: Ewart, Fl. Vic. (1931) 407, p.p. (as to Vic. occurrences).

Hakea sp. *1:* E.M. Ross in T.D. Stanley & E.M. Ross, Fl. S. E. Qld, 2 (1986) 21.

Tall or low spreading shrub or small tree, 0.6–4.5 m high; lignotuber absent *(W.R. Barker* collns); *branchlets* with 1 rib decurrent from each leaf base, densely woolly tomentose when young , usually persistent long after flowering, sometimes glabrescent by that time. *Leaves* usually widely spreading, sometimes obliquely, rarely narrowly so, rigid or flexible, (1.3)2–4.3(5.3) cm long, 0.7–1(1.1) mm wide, with longitudinal groove on lower side, often towards base, sometimes to or almost to apex, initially moderately appressed-sericeous, with long shining coarse hair arms, quickly glabrescent, porrect, with mucro (1)1.2–1.8(2.0) mm long. *Inflorescence* an axillary umbel; forming in a cone-like involucre 1.4–2.2 mm long; *inflorescence-subtending bracts* 0.5–1.5 mm long, light to mid brown or yellow-brown, ciliolate, but otherwise glabrous; *rachis* single in axil, rarely developing from old woody rachises of prior season, obscure to elongated, 0.5–2.2(2.8) mm long, densely woolly tomentose, with white hairs and towards base (probably on shoots) rust-brown hairs, sometimes supporting a single bud near lowest flower, persistent; *flowers* (1)4–5(6), arranged singly, *pedicels* 2.2–4.6(5.0) mm long, moderately to densely villous to hirsute, with white hairs; *torus* oblique, sometimes almost transverse; *perianth* 2.5–4.7 mm long to the recurved apex, white or cream-white, glabrous, splitting into 4 free tepals displaced to the gland side of the flower opposite the displaced pistil ; *anthers* 0.3–0.5 mm long with pollen; *gland* a small U-shaped to flat flap, (0.15)0.2–0.25(0.3) mm high, 0.15–0.25(0.35) mm wide laterally, with upper margin shallowly emarginate; *pistil* vertically rarely obliquely, inserted, with gynophore curving away from gland, (4.5)5–7(7.5) mm long, the style recurved, the pollen-presenter oblique, discoid , 0.1–0.2 mm high, 0.6–0.8 mm wide laterally, usually topped by a filiform erect apiculum 0.1–0.4 mm long, bearing the stigma at the apex. *Fruits* 1–2 in each axil, persisting closed for some seasons; *body* broad ovate to circular in median view, (2)2.5–3(4) cm long, finely to coarsely pusticulate, becoming rugose-reticulate, with crests rupturing, with the *beak* small to moderately large, transverse or oblique and shortly to long decurrent down the one side of the body, with surface usually similar, sometimes different from body; *stalk* with 2 parts derived from the pedicel and gynophore; *horns* 0.5–2(3) mm long, often relatively obscure; *valve* obliquely ovate to obliquely depressed ovate, (1.5)1.7–2.2(3.0) cm wide; seed cavity almost porrect to slightly oblique relative to the valve axis; red-brown wood zone 1.5–3 mm wide at widest near base of seed; pale wood zone 8–16 mm wide, 0.35–0.5 times width of valve, 2-layered, the outer layer 2–7 mm wide. *Seed* elliptic to obovate-elliptic or obliquely so, (16)19–25(31) mm long, (6)7–10(11.5) mm wide, dark brown or black; *body* obovate to broadly obovate or obliquely so, (4.6)5.5–8.7(9.0) mm long, finely rugose to rugose-reticulate or tuberculate, a distal absent; *wing* decurrent fully down one side of the body only or fully down both sides or completely encircling it, though of unequal width on each side. (Fig. 2I).

Distribution (Map 3) *& ecology*: Found in coastal regions and adjacent ranges from south-east Queensland (Mt Mee, Mt Barney, Mt Maroon) to south-eastern New South Wales. It has also been recorded from Anglesea, Victoria (*Lee 353*); this is most likely an adventive occurrence. The species occurs in dry sclerophyll forest and heaths. Flowers July–Oct.

It has also become naturalised in New Zealand and South Africa, where it is a troublesome weed (Sykes 1988; Kluge & Neser 1991). *H. sericea* has been recorded for Norfolk Island (e.g. Green 1994);fruiting material examined in its fine foliage resembles more *H. sericea* than *H. decurrens* ssp. *physocarpa*, but flowers are needed for unequivocal recognition. The little material seen from Europe is *H. decurrens* (q.v.). The published records of *H. sericea* from southern Europe (e.g. Ball 1964) may also be that species.

Notes

1. The restricted Queensland occurrences of this species have previously been recognised either as *H. gibbosa* (Bailey 1901) or a glabrous form allied to it or a new species (Ross 1986).

2. The authorship of *H. sericea* and of the genus *Hakea* itself has been changed by me (e.g. W.R. Barker 1986) to Professor H.A. Schrader's alone on the basis of an 1805 review of literature (Anon. 1805), probably by the editors of *Annals of Botany*, C. Koenig and J. Sims, which ascribed authorship of the relevant part of "Sertum Hannoveranum ..." to Schrader, discordant with that shown on the title page of the part in which it was attributed also to the artist J.C. Wendland. The title page of the first part of the "Sertum Hannoveranum ..." indicates that it was written solely by Schrader. However, with confirmation (Stafleu & Cowan 1985), it is likely that this reviewer simply missed noting the joint authorship indicated on the title pages of parts 2 and 3. A transition period of co-authorship is likely, considering that by the fourth part J.C. Wendland was acknowledged as the sole author.

3. Salisbury's (1796) *Banksia pinifolia* has consistently been cited as a synonym of *H. gibbosa* from soon after its publication (e.g. Smith 1807). This has probably arisen from Salisbury's indication that the two species were conspecific. Salisbury's substitution of his own epithet to replace the only name to that time coined from White's material, "*Banksia gibbosa*", was a common practice by him and J.E. Smith in that period (R.M. Barker & W.R. Barker 1990).

Typifications

While there is no authentic Salisbury material, herbarium collections of the period indicate that *B. pinifolia* was a fine-leaved form of *H. sericea*. These specimens, originate from various gardens in the late 1700s and early 1800s, were identified variously as "*Banksia pinifera*" and "*B. pinifolia*" (MO3336120; ex "Bernhardi Herbarium", dated 8.iv.1796), "*Hakea pinnata*" (E: ex "Hort. Bot. Glasg[ow]"), and "*H. pinifolia* Salisb." (K: ex "Jardin des plantes, Orangerie, 16e Mars 1819"). In addition, a BM sheet, annotated at some time with "*Conchium aciculare*" and "*Hakea acicularis*", may indicate that White was the original source of seed of these garden plants. The sheet has material with fine foliage very similar to the above specimens, one from the Smith Herbarium collected by White, another from "Hort. Kew". White's seed may have been distributed to Malmaison where Ventenat took up Smith's name "*Conchium aciculare*", and to Lee, the provider of Salisbury's specimens (cf. R.M. Barker & W.R. Barker 1990), upon which Salisbury coined the name "*Banksia pinifolia*".

Examination of Salisbury's description gives further support to this. Based solely on foliage, it is identical to that of his *B. tenuifolia*, published in the same place, apart from the reference to the former as having dense ("densis") leaves and the latter crowded ("confertis") ones. If Salisbury had both *H. sericea* and *H. gibbosa* he would have certainly distinguished them on their conspicuous leaf indumentum difference. In the absence of descriptions of flowers and fruits, he presumably did not have fertile material to assist him, nor would White's (1790) illustration of *"B. gibbosa"* have been likely to help him if he did have fruits as it does not bring out the transverse orientation of the seed in the fruit of the species.

Additional specimens examined (260 seen):

QUEENSLAND. ***Moreton***: *S.L. Everist 7084*, 10.iii.1962, Mt Maroon north peak summit basin at foot of southern slope, BRI. –*C.T. White 7862*, 27.viii.1931, Mt Barney, BRI, NY. –*P. Young 881*, 17.ii.1985, Mt Mee State Forest, c. 50 km NW of Brisbane, BRI.

NEW SOUTH WALES. ***North Coast***: *W.R. Barker 5631 & I.R. Telford*, 9.ix.1988, C. 2.5 km WNW of Kungala, c. 300 m N of turnoff to Kungala on the road by the Orara River between Grafton and Coffs Harbour, AD. –*M.E. Phillips 357*, 21.ix.1972, Near North Rothbury, CBG, NT. –*J.B. Williams s.n.*, 15.viii.1965, c. 15 km N of Glenreagh, NW of Coffs Harbour, NE 43355. – ***Central Tablelands***: NSW/ct : *Constable E.F. s.n.*, 3.xii.1948, Mt Wilson, NSW 27331, W 10917, NY. – ***Central Coast***: NSW/cc: *W.R. Barker 5664, B.J. Conn & D.S. Gibbons*, 17.ix.1988, Wisemans Ferry Road, c. 1.5 km by road E of Central Mangrove towards Somersby, AD. –*S.T. Blake 19037*, 24.viii.1952, Audley near Pt Hacking, in National Park, BRI, NSW. –*A. Meebold 2704*, ii.1929, Sutherland near Sydney, M, NY. – ***Southern Tablelands***: *D.J. McGillivray 1435*, 22.ix.1965, c. 10 m S by W from Bungonia, NSW. – ***South Coast***: *R.D. Hoogland 10029*, 16.ix.1965, Pigeon House Range, along road from Nerriga to Nowra c. 2 m E of the Endrick River, CANB (many dupl. distributed). –*F.A. Rodway 15748*, 24.viii.1953, Swan Lake, S of Jervis Bay, NSW. –*C.J. Shepherd 817*, 12.ix.1978, Kiola State Forest; Livingstone Creek catchment, 15.5 km NNE of Batemans Bay, CANB.

VICTORIA. ***Western Coastal Plain***: *H.M. Lee 353*, 2.x.1986, *D. Catling & H.M. Lee s.n.*, x.1988, Harvey St, Anglesea, AD.

NORFOLK ISLAND: *Sykes W.R. Norfolk-620*, 15.iv.1980, Melanesian Mission area (St. Barnabas' Chapel), CHR.

NEW ZEALAND: *Orchard A.E. 3383*, 20.vii.1972, North Island, Green Bay, a western suburb of Auckland, NT. – *Orchard A.E. 3601*, 14.x.1972, North Island, Whangaroa County, c. 10.5 km due W of Kaeo, at junction of Otangaroa and Taratara Roads, NT.

SOUTH AFRICA: *Bos, J.J. 73*, 18.vi.1953, Foot of Stellenbosch Mnt., behin "Coetzenburg", STE. – *Fugler, S.R. 59*, 20.ix.1976, Miss Grace's farm - Molenrivier. South Cape region, STE s.n.. –*Walters I.B.* 2031, 24.vii.1980, Near Wyzersdrift bridge, Goudini, Worcester, Cape Region, NBG 129976.

H. pachyphylla Sieb. ex Sprengel, a species of the *H. nodosa* R. Br. group confused with *H. propinqua* Cunn. in the Sydney-Blue Mountains region

H. propinqua was formerly considered to be widespread in central and northern tablelands and coast of New South Wales extending into south-eastern Queensland. Under this former circumscription, two newly named species in the *H. sericea* group, *H. actites* and *H. macrorrhyncha*, described herein, made up the northern occurrences in this range. In addition, many publications in the past have referred to two forms of the species in the Sydney region and adjacent mountains (e.g., Beadle & Carolin 1972; Stacy 1977). They constitute two very distinct species. Failure to formalise them taxonomically probably arose from the similarity of their non-fruiting herbarium specimens, for which flower colour was rarely provided, and their overlapping ranges of distribution Under its revised circumscription *H. propinqua* is the white-flowered, winter-flowering small tree of the coastal plain and intothe adjacent ranges, including the Blue Mountains. The yellow-flowered, spring-flowering small shrub restricted to the upper parts of the Blue Mountains is a separate species, distinct on habit, floral and fruit characters, to which the long synonymised *H. pachyphylla* of Sieber pertains.

The *H. nodosa* group comprises three species confined to south-eastern Australia. It is allied to the needlewoods, but is characterised by tiny white or yellow flowers and generally more flexile leaves than for example in most species of the *H. sericea* group (*H. macraeana* and *H. ochroptera* excepted). The perianths of this group are 1.5–2.2 mm long, those of the *H. sericea* group over 2.5 mm long; the pistils are similarly much shorter.

Key to the *H. nodosa* group of species

1. Leaves flexible, often flattened; plants producing woody and non-woody fruits; rachis simple or with up to 6 sessile branches on prior years rachis; seed marginal in the valve; [flowers cream-white to deep yellow; closed heath and swampy areas, SE SA, Vic, NE Tas; flowers May–Aug.] .... ***H. nodosa*** (p. 200; Fig. 3A; Map 4)

1. Leaves rigid, always terete; plants producing only woody fruits; rachis simple; seed distant from the valve margin, though not exactly central
   2. Conifer-like tree or shrub, 1–5 m high; flowers white; fruits 3.5–4.5 cm long;[Sydney region to Blue Mtns, NSW; flowers usually May–July] .... ***H. propinqua*** (p. 202)
   2. Compact or spreading shrub, 0.5–2 m high; flowers yellow; fruits 2.9–3.5 cm long; [Blue Mountains, possibly also Budawang Ranges, NSW; flowers usually Aug.–Sep.] .... ***H. pachyphylla*** (p. 204)

H. nodosa R. Br., Trans. Linn. Soc. London 10 (1810) 179.

Type citation: "In Novae Hollandiae ora australia, prope Port Phillip; ad latera montium. (ubi v.v.)." Ex manuscript: "...Bauer no. 116, Bay XVI, April 30, Desc. May 3: 1802]."

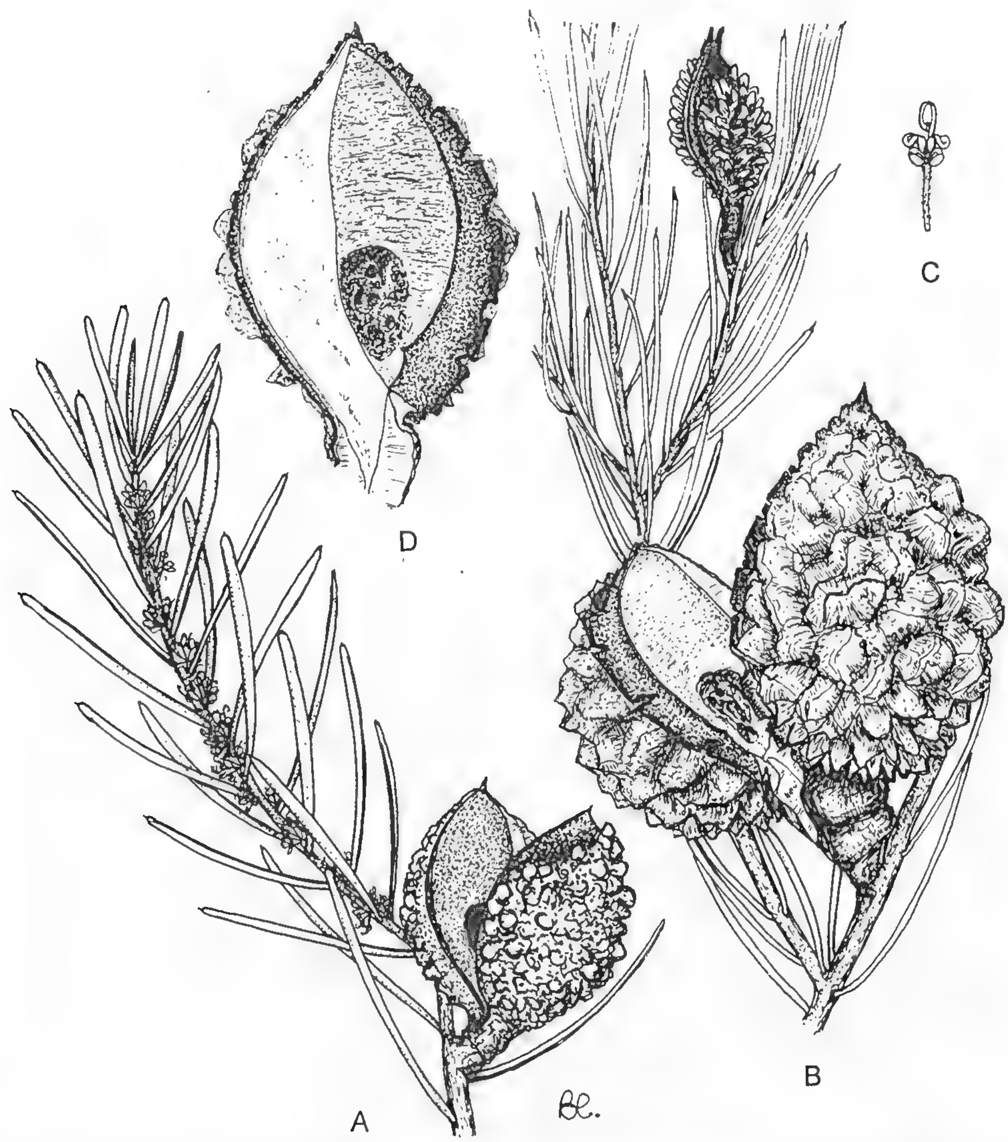


Fig. 3. ***Hakea*** Sect ***Hakea***, the "***H. nodosa*** group". A, ***H. nodosa*** (flowering and fruiting branch ×1). B–D, ***H. propinqua*** (B, branch with young and mature fruit ×1; C, flower ×3; D, valve, inner face ×1). (A, *Wilson 769*; B, D, *Seur 391*; D, *Eichler 17010*). (Del. B. Chandler).

Lectotypus hic designatus: *R. Brown* [*J.J. Smith no. 3384*], 1 v. 1802, Port Phillip / Iter Australiense,1802-5, BM. *Isolectotypi*: *R. Brown s.n.*, v. 1802, P[ort] Phillip, K; *R. Brown s.n.*, 1802, Port Phillip, P (ex K); *R. Brown* [*J.J. Smith no.*], *3384* s.dat., Port Phillip, Victoria, Iter Australiense, 1802-5, E; *R. Brown s.n.*, s.dat., P[ort] Phillip, Iter Australiense, 1802-5, E. *Isolectotypus possibilis*: *R. Brown s.n.*, s.dat. Port Phillip, Arthurs Seat, Iter Australiense 1802-5, E.

H. flexilis R. Br., Trans. Linn. Soc. London 10 (1810) 180.
Type citation: "In Novae Hollandiae ora australia, prope Port Phillip; ad latera montium. (ubi v.v.)." Ex manuscript: "In lateribus Montis Arthur's Seat, ad Port Phillip, Feb. 1804."
Lectotypus hic designatus: *R. Brown 3375*, 24-25 i.. 1804, Port Phillip, in lateribus collium Arthur's Seat, / Iter Australiense 1802-5, BM. *Isolectotypi*: *R. Brown s.n.*, January 1804, Port Phillip, / Port Phillip, Arthur's Seat, / Iter Australiense 1802-5, BM; *R. Brown 3375*, s.dat., Iter Australiense 1802-5, K; *{R. Brown] s.n.*, i.. 1804, Port Phillip, Arthurs Seat, K (p.p.: middle of three specimens).

H. semiplana F. Muell. ex Meisn., Linnaea 26 (1854) 359.
Type citation: "Brighton, Australia felix [Victoria], Oct." *Lectotypus hic designatus*: *Dr Ferd. Müller s.n.*, x. [18]52, Brighton, Australia felix, NY (herb. Meisner, ex herb. Sonder) p.p. *Syntypi alteri, non isolectotypi*: *Anon. s.n.*, 1853, Gippsland, NY (herb. Meisner) p.p.; *Anon.* (*Major Mitchell's Expedition*) *s.n.*, Interior of New Holland, NY (herb. Meisner) p.p.

H. semiplana F. Muell., First Gen. Report (1853) 17, *nomen nudum.*

Notes

The variability in leaf form and in fruit surface in *H. nodosa* has been alluded to in W.R. Barker (1986). Observation in the field indicates that there two fruit types can occur on a plant (*W.R. Barker 5441-5, 5447, 5527*). Most fruits had the typical breadth of species of Sect. *Hakea*, but, apparently developing towards the end of the pollination period, additional fruits compressed through the development of little woodiness are also present. These latter fruits were opening on the bush in April 1987; they presumably dehisce more frequently than the much woodier fruits, probably annually, as with fruits of other species with little woodiness. From the plants seen *H. nodosa* also can reproduce vegetatively by subterranean suckering. Mr W. Molyneux (pers. comm. 1992; *Molyneux AD99625002*) observed similar small smooth fruits and suckering in the eastern part of the species distribution.

Typifications

There are two collections which are Robert Brown's which can be readily assigned to the two Brownian species by the collecting dates and morphological characters presented in the manuscript and publication (leaf shape compressed in *H. nodosa*, more or less terete in *H. flexilis*, flowers present in the former not the latter, fruits smooth in the latter, tuberculate in the former). A third collection, in E, is sterile and has large subterete leaves. It may be an isolectotype of either of the two species or may be a separate gathering, possibly *Bauer 116* referred to under *H. nodosa* in Brown's (unpubl.) manuscript, if that was a separate collection.

H. nodosa R. Br.

The BM specimens was chosen as lectotype, despite flowering branches being insect eaten, as it bears flowers and fruits, including a seed in an attached packet, and bears original labels written by Brown and is equal in condition and content to other specimens.

As in the K isolectotype, Brown has appended a note indicating a need to compare it with his *H. flexilis*, indicating it was part of his working herbarium.

Brown (unpubl.) has indicated that he made the type collection on April 30, but the additional date of May 1 has been added to a typed label on the lectotype.

H. flexilis R. Br.

The BM collection is chosen as lectotype as it is similar in condition and content with three branches, two with fruit, has a packet of seed, and includes an early manuscript name

"Conchium molle" in Brown's hand. There is no specimen with *H. flexilis* written in Brown's hand.

H. semiplana Meisn.

Only one specimen was cited by Meisner in the protologue, but three specimens of *H. nodosa* in his herbarium in NY are annotated with this nameNo duplicates are apparent in MEL The cited specimen is taken as the lectotype. It comprises two packets containing material of *H. nodosa*. Both are identified as *H. semiplana* in Meisner's hand.

Additional cited specimens:

VICTORIA. ***Eastern Highlands***: *W. Molyneux s.n.*, 4.x.1992, c. 4.5 km SSW of Toolangi, paul Range, AD99625002. – ***Western Coastal Plains***: *W.R. Barker 5441-5 & R.M. Barker*, 18.iv.1987, *R.M. Barker per W.R. Barker 5527*, 27.ix.1987, G.T. & J. Short's property, c. 22½ km SSW of Casterton, c. 3 km E of Casterton-Dartmoor road, AD. – *W.R. Barker 5447*, 19.iv.1987, Crown land along E boundary of G.T. & J. Short's property, ..., AD.

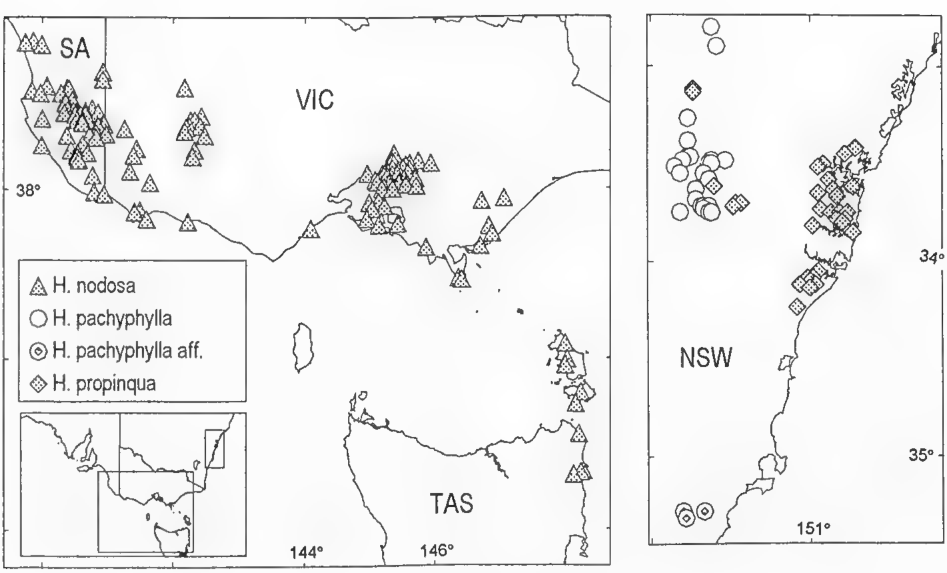
H. propinqua Cunn. in Field, Geog.Mem.N.S.Wales (1825)327; Benth., Fl. Austral. 5 (1870) 513, p.p. (as to *Cunningham* specimens); Beadle in Beadle, Evans & Carolin, Fl. Sydney Reg. (1963) 187, p.p. (as to "coastal forms" with white perianth).
Type citation: "At about eighteen miles on the Blue Mountains." *Lectotypus hic designatus: A. C[unningham] s.n.*, x.1822, Near Caley's Repulse on an open very rocky elevated point of the road over the B[lue] Mount[ai]ns. 12-15 feet high; Hakea propinqua, C. (pachyphylla Sieb.) [All in A. Cunningham's hand], K(herb. A. Cunningham, p.p.: lower left specimen). *Probable syntypes, isolectotypes: A.* C[unningham] *s.n.*, x.1822, Rocky ridges on the Blue Mountains, Port Jackson, G-DC (microfiche AD); *Anon. (Cunningham) 54*, x.1822, A tree 15 feet high on the Blue Mountains near Port Jackson, BR (in Cunningham's hand). *Possible isolectotype: Anon. s.n.*, s.dat., s.loc., K (herb. A. Cunningham, p.p.: top right specimen of lectotype sheet). *Syntype, possible isolectotype: Anon. 33*, Novr or Decr, 1822, A large shrub about 18 miles on the Blue Mountains, BM p.p. (in Brown's hand). *Possible syntypes, not lectotypes* (*H. pachyphylla* Sieber): *Cunningham 195 or 33* (2 labels), 1822, Blue Mountains, BM (probably mislabelled at least in part); *Mr Bar[nad] per B. Field 3*, s.dat., Without locality, BM p.p. (on sheet bearing isolectotype *Cunningham 33*, annotated by Brown); *A C[unningham] s.n.*, s.dat., Without locality, K(herb. Cunningham). *Possible (iso)syntype, not isolectotype*: *Anon. 33*, s.dat., Blue Mountains, 12 feet high, MEL1537936 p.p.

H. verrucosa auct. non F. Muell.: F. Muell., Fragm. 5:25 (1865)p.p. (with respect to fruiting specimens and description of the fruit in the protologue and to cultivated flowering specimens of *H. propinqua* distributed overseas by Mueller as *H. verrucosa*).

Small symmetrically shaped (conifer-like) tree or shrub to c. 1–5 m high, non-lignotuberous, with its smooth single stem often swollen by evenly spaced fissured swellings; young branches in fresh state deepish red, at least when dried finely prominently longitudinally multi-ribbed through 3 main ribs decurrent from each leaf base well past node below, moderately to densely raised tomentose, quickly glabrescent and hardly apparent to persisting over much length to past flowering, the indumentum more persistent in the grooves between ribs. *Leaves* usually narrowly angled to branches and tending to point in one direction, terete but flat at very base with lateral flanges extending onto terete section, not grooved, (1.5)2.5–7(8.5) cm long, 1.0–1.3 mm broad, somewhat flexible, usually minutely densely colliculate, rarely scaberulous particularly towards base; mucro 0.7–1.6 mm long. Inflorescence axillary, an umbelliform raceme; in bud with cone-like involucre of bracts, these glabrous but for white pubescent apex externally and ciliate margins towards apex, deciduous from an eventually ± swollen rachis base c. 0.5 mm long; *flowers* white, (4)6–10, singly arranged along rachis, without subtending bracteoles; rachis terete, very slender, simple, (0.6)1.5–2.5(3) mm long (excluding swollen involucral base), densely white tomentose; *pedicel* slender, 2–3.8 mm long, sparsely to moderately densely white tomentose (with same hairs as rachis); torus horizontal; *perianth* 1.5–2.2 mm long to apex of recurved distal part of tube, glabrous but for a few raised-armed white hairs on limb, splitting into 4 tepals; *anthers* 0.35–0.4 mm long; *gland* minute, U-shaped, (0.15)–0.2 mm high, 0.2(–0.25) mm wide laterally; *pistil* 4–4.5 mm long, straightened, the (0.2)–0.3 mm long stipe directed obliquely backwards, the pollen presenter obliquely inserted on style, discoid, 0.5–0.6 mm long laterally, 0.1(–0.2) mm high, sometimes with the central fine stigmatic projection 0.5 mm long. *Fruit* long remaining closed; when young (from

Barker 5666: Sept., Oct., Feb.) mid green with dense thick blunt plate-like longitudinally oriented yellow tubercules, often prominently 2-horned and with suture decurrent from between horns deep brown, in mature state deep brown-black with stout smooth stalk (4)10–15(21) mm long composed of pedicel (1)3–6(8) mm and stipe (3)6–10(15) mm long separated by prominent articulation, with main fruit body straight-inserted; beak smooth or sparsely tuberculate, short and broad, decurrent down the red-brown wood side only; rest of fruit body sharply to bluntly, densely, very coarsely tuberculate; apex obtuse with apiculum obscure or absent; horns to 1–2 mm long, often worn, sometimes as a result absent; valves broadly ovate-elliptic, 3.5–4.5 cm long, 2.5–3.0(3.8) cm wide, the seed tending to central through very wide red-brown wood zone (6)7–8(9.5) mm wide; white wood zone equal or wider, (7)7.5–10(12) mm wide, composed of one wide white/red-brown layer and a very narrow marginal white layer. *Seed* obliquely elliptic, 2.4–3.8 cm long, (1.1)1.2–1.3(1.5) cm wide; *seed body* obliquely obovate, 9–14 mm long, 5–9 mm wide, black, well-spaced broken, mainly longitudinally, high rugose to spaced mainly longitudinal plate-like tubercles, rarely fine low rugose; *wing* brown-black, decurrent 2/3–3/4 down one side, if compressed ± narrow margin of seed body included, then extending all round. (Fig. 3, B–D).

Distribution (Map 4) *& ecology*: *H. propinqua* occurs in two separate areas in New South Wales, the first in near-coastal areas from Heathcote National Park through the bounds of Sydney and north to the ranges near the lower Hawkesbury, the second to the west in the lower Blue Mountains. It is scattered to locally abundant in *Eucalyptus* woodland or open forest, mixed sclerophyll scrub or shrubland on shallow sandy or loam soil on sandstone of ridgetops, hillsides, cliff bases or flats. Flowers (April) May-July (August), with a single October record.



Map 4. Distribution of the "*H. nodosa* group". *H. nodosa, H. propinqua* and *H. pachyphylla*.

Notes

1. *H. pachyphylla* has been long confused with this species, but differs in its high Blue Mountains distribution, low bushy habit, yellow flowers and smaller fruits with more irregular and blunt warty outgrowths.

2. In my experience *H. propinqua* commonly has prominent swellings, apparently galls, on the branchlets (*Barker 5666, 5678*).

Typification

The protologue describes both flowers and fruits. The syntypes comprise flowers of *H. propinqua* and fruits of specimens of *H. pachyphylla*. There is considerable confusion amongst material which is associated on sheets with the syntypes and possible syntypes. Other specimens, including some *H. pachyphylla* (see below) are mounted on the lectotype sheet and there may have been some mixing of labels, so that further specimens may even be isolectotypes or isosyntypes.

Cunningham in his 1817 journal of Oxley's Expedition (Currey 1967) refers to the "18th mile mark (from Emu Ferry) on the Blue Mountains" as being the site of a cairn erected by Caley and known amongst other names as Caley's Repulse.

The lectotype is chosen as it is amongst the best specimens, has the label fully annotated by Cunningham attached to it and is in the Cunningham herbarium.

Brown has indicated that a Sieber specimen in BM of *H. pachyphylla*, which Brown identified as *H. propinqua*, "agrees exactly with the specimen no. 3 in Barron Field's herbar[ium]". It is possible that this material is also a syntype of *H. propinqua* and that this is the source of the syntype material of *H. pachyphylla*, for it agrees well with the specimen mounted with the lectotype on the herb. Cunningham sheet and its apparent BM duplicate.

Selected specimens examined (82 seen):

NEW SOUTH WALES. ***Central Tablelands***: *E.F. Constable 4979*, 19.viii.1964, 8 m NNE of Leura, on Mt Hay road, Blue Mountains, NSW. –*R. Coveny 9454 & I. Telford*, 18.v.1977, 2 km SSW of Glen Davis, NSW, CBG. – *I.R. Telford 5029 & G. Butler*, 25.x.1976, c. 40 km NNE of Lithgow, 2.5 km SSW of Glen Davis, Green Gully, CBG. – ***Central Coast***: *J. Armstrong 896*, 1.vi.1976, West Hd Rd 2 km N of Salvation Creek-Kuring-gai Chase N.P., NSW. – *W.R. Barker 5666, B.J. Conn & D.S. Gibbons*, 17.ix.1988, Marra Marra Nat. Pk, c. 3.2 km by road SSE of Maroota School, on Wisemans Ferry - Dural road, AD.– *W.R. Barker 5678 & D.S. Gibbons*, 20.ix.1988, Wakehurst Parkway, Sydney, c.1.8 km from Warringah Road, AD. –*C. Burgess s.n.*, 13.ix.1962, Waterfall, CBG 10541. –*E.F. Constable s.n.*, 26.ii.1948, Woronora Dam, BR (2 sheets), NSW 5321 –*R. Coveny 11609 & W. Bishop s.n.*, 1.ix.1983, Scouters Mountain, Heathcote National Park, NSW. – *Hj. Eichler 17010*, 7.v.1960, On Princes H[igh]way ca 1.5 km SSW of Heathcoat, AD. –*K. Moore s.n.*, ix.1963, Dillons Farm Rd, 1 m from Woy Woy turnoff, on the Somersby-Woy Woy road, NSW 182241. –*J. Seur 391 & E. Wilksch s.n.*, 21.x.1978, Willoughby, Hallstrom Park Reserve, Flat Rock Creek gully, NSW.

H. pachyphylla Sieber ex Spreng., Syst. Veg. ed. 16, 4(2) Cur.Post.: 46 (i.–vi..1827); J.A. Schultes & J.H. Schultes, Mant.Syst.Veg.Linn. 3: 282 (vii..- xii. 1827) 282.
Type citation: "[Sieber] 35 ... Nov. Holl.". *Lectotypus hic designatus*: *Sieber 11*, s.dat., Nova Hollandia, MEL 674170 (herb. Sonder). *Isolectotypes and possible syntypes*: G-DC (microfiche AD), L, BR, H (2 sheets), M, K, G, MEL 1537928, MEL 674170, NY, MO.

H. propinqua auct. non Cunn.: Benth., Fl. Austral. 5 (1870) 513, p.p. (as to *Sieber 11*); Beadle in Beadle, Evans & Carolin, Fl. Sydney Reg. (1963) 187, p.p. (as to "forms from higher Mts" with yellowish perianth).

Compact, bushy to spreading or much depauperate shrub, 0.3–2 m high; non-lignotuberous with single stem (*Barker 5672*); *branchlets* multi-ribbed through a rib decurrent from each leaf base past several nodes; branchlets initially densely appressed-pubescent with a few raised hair arms, ± quickly glabrescent or persistent to flowering, mid-red when young. *Leaves* rigid ascending, often at a narrow angle to the subtending branch, (1.0)1.8–3.5(5.5) cm long, 1.1–1.8 mm wide, terete, when young sparsely +/- appressed pubescent, quickly glabrescent, also minutely densely "scaberulous" (? by retention of microscopic hair bases); base with narrow flange either side to some way up

leaf, sometimes with groove on lower side to a short way up; mucro c. 0.5–1.5 mm long. *Inflorescence* axillary, an umbelliform raceme; in bud with deciduous cone-like involucre of ciliate bracts; *flowers* (1–)3–6(7); rachis knob-like to terete, single, simple, 0.5–1.2 mm long, densely woolly-tomentose with white shortish soft (but not intertwined) hairs, possibly elongating after flowering as white pubescent to glabrous remnants, very slender to 0.5(2) mm long; *pedicels* slender, 1.8–3.3 mm long, moderately densely woolly tomentose; torus ± horizontal; *perianth* 1.5–2 mm long (to curved apex), with tepals recurved such that limb back down to torus, glabrous but for sparsly raised tomentose or 1 or 2 raised hairs on limb, rarely glabrous throughout, split into 4 parts; *anthers* 0.25–0.35 mm long; *gland* minute, 0.15–0.2 mm high, c. 0.1–0.25 mm long; *pistil* bent back at base, (3.5)4.2–4.5 mm long (straightened), the stipe c. 0.2–0.25 mm long, the pollen presenter discoid, 0.5–0.6 mm side, hardly projected forward (c. 0.05–0.2 mm high). *Fruit* long remaining closed, when young (Nov.–Dec.) sharply coarsely tuberculate, with tubercles apparently contrastingly lighter colour than rest of surface (*Hamilton NSW182525*); when mature rachis 0.1–0.4 mm long, 0.4–0.9 mm diameter, separated from stalk by articulation and obliquely to widely divergent from it; stalk 0.3–0.6 mm long, 0.7–1.4 mm diameter, "straight" into body; beak tuberculate, short and broad, decurrent unequally down both sides of fruit body, on red-brown wood side broad, on white wood side very narrow; rest of fruit body very coarsely bluntly tuberculate; the apex truncate to broadly acute, with apiculum obscure to 0.2 mm, the horns obscure or absent; valves elliptic, 2.9–3.5 cm long, 2.3–2.6 cm wide, the seed cavity displaced from centre but not marginal; red-brown wood zone 6–7 mm wide; white wood zone, broader, 9(10) mm wide, comprising two obscure to distinct ± equal layers, the inner yellow-brown, the outer whitish to yellow-brown. *Seed* elliptic to obliquely obovate, 22–25 mm long, 10–12 mm wide; *seed body* obovate, 8–10.mm long, 5–6 mm wide, brown-black, interrupted-rugose (scattered longitudinally parallel broken ridges), lacking apical extension onto the wing; *wing* hardly encircling the body, deep brown, decurrent broadly down one side, very narrowly down the other and very narrow around base.

Distribution (Map 4) *& ecology*: *H. pachyphylla* is confined to the upper parts of the Blue Mountains of eastern New South Wales. It is recorded as common or localised, on sandstone in shallow soil, usually on exposed sites, but also in a swampy area or in dry, small creekbed, often in heath or mallee-heath. Flowers August to September, with one 20 October record.

Typification

The choice of lectotype is amongst the better annotated possible syntypes.

The Sieber number *35* recorded in the protologue is incorrect. All type material seen and the subsequent description of the species by Schultes & Schultes (1827) and Dietrich's (1881) list of Sieber's Australian collections consistently record the collection number as *11*, with Dietrich (l.c.) recording the number *35* as "Grevillea oleoides Sieber". There is no evidence that Sieber might also have collected *H. propinqua*, as narrowly defined here.

Note

Three specimens most closely allied to *H. pachyphylla* come from the Northern Budawang Range (*Pulley & Telford BR75*, *Carolin 7055*) and the adjacent Little Forest Plateau (*Mills NSW223475*), about 130 km to the south of the range of distribution of *H. propinqua* and *H. pachypylla* of the Sydney region and Blue Mountains. Like these two species they have ribbed branchlets, the leaves lack grooves, the rachises are simple and short (c. 0.6 mm long), and the fruits are bluntly warted with the seed distant from the valve margin though off centre in the valve. The flowers or buds on the *Mills* and *Pulley* specimens are of similar size to the *H. nodosa* group, and have the group's white-tomentose pedicels and a glabrous perianth. While *Pulley & Telford BR75* differs from both in the very narrow leaves, possibly with a texture and flexibility akin to *H. nodosa*, but possibly indicative of a shade form, and in the shortness of the fruit beak, the *Carolin* and *Mills*

specimens match *H. pachyphylla* in fruit surface, shape and beak, as well as in the robust leaves. Population samples including flowers, with notes on colour, are required to confirm conspecificity with *H. pachyphylla.*

Selected specimens examined (50 seen):

NEW SOUTH WALES. ***Central Tablelands:*** *W.R. Barker 5672*, 19.ix.1988, Du Faurs Rocks, Blue Mtns Nat. Park, AD. *–J.L. Boorman s.n.*, viii.1908, Zig Zag cutting (Clarence Siding), overlooking Lithgow, NSW 182522. *–J.L. Boorman s.n.*, x.1914, Hassans Walls, Lithgow, NSW 182523. *–C. Burgess s.n.*, 11.iv.1962, Above Centennial Glen, Blackheath, CBG 5563. *–C. Burgess s.n.*, 18.viii.1958, Leura, CBG 6566. *–E.F. Constable 6107*, 21.ix.1965, Lake Medlow, Medlow Bath, 3 m NNW of Katoomba, Blue Mountains, NSW. *–R. Coveny 12149, W. Bishop & R. Makinson,* 17.ix.1985, "Little Switzerland" on Kings Tableland, Wentworth Falls, NSW, AD. *–D.J. McGillivray 1421*, 21.ix.1965, 14 m from Clarence on road following the disused Newnes railway line, NSW. *–D.J. McGillivray 1590*, 13.ii.1966, Bare Rock, c. 25 m directly E of Rylstone, NSW. *–R. Melville 646 & Johnson L*, 29.viii.1952, Kings Tableland, S of Wentworth Falls, Blue Mts, MEL, AD, BRI. *–A. Rodd s.n.*, 4.vii.1965, Mt Banks, NSW 182526. *–A.N. Rodd & D.J. McGillivray 1172*, 26.iv.1965, 11 m N of Gospers Mountain Army Airstrip, 9 m NE of Glen Davis on military road, NSW.

Specimens with apparently closest affinity to H. pachyphylla:

NEW SOUTH WALES. ***South Coast***: *R. Carolin 7055 & J. Grieve*, 15.iii.1969, Byangee Walls, SYD; *K. Mills s.n.*, 11.viii.1988, Banner C[ree]k, Little Forest Plateau, Morton National Park, NSW223475; *J. Pulley & I. Telford BR75*, 17.vi.1971, Northern Budawang Range, The Castle; rocky slope at base of cliff, SW apsect; sandy soil on sandstone; open *Eucalyptus* forest-heathland; 2 m shrub, CBG.

Further typifications and notes

H. macraeana F. Muell., Australasian J. Pharmacy 1(11) (1886) 430.

Type citation: "Near the sources of the Shoalhaven-river and near the eastern tributaries of the Snowy-River, at elevations of nearly 4000 feet; W. Baeuerlen." *Lectotypus hic designatus*: *W. Baeuerlen s.n.* (p.p.), x.1886, Sources of the Clyde, 4000 feet, MEL1537921 p.p. (flowering branch). *Isolectypi et syntypi*: BM, K. *Isoloectotypus possibilis, non syntypus*: *W. Baeuerlen s.n.*, ix.1886, Monga, near Braidwood, NSW191568, but note different date. *Syntypi alteri*: *W. Baeuerlen s.n.* (p.p.), x.1886, Sources of the Clyde, 4000 feet, MEL1537921 p.p. (fruiting branches); *W. Baeuerlen s.n.* (p.p.), x.1886, Near Mt Currockbilly, MEL1536165; *W. Baeuerlen 206*, ix.1884, Braidwood District, MEL1537922 p.p.; *W. Baeuerlen 206*, ii.1885, Braidwood District, MEL1537922 p.p.; *George McRae s.n.*, 1885, Braidwood, MEL1536164.

Two problems surround the material studied by Mueller around the time of publication of the protologue (Mueller 1886). One concerns a possible mixing of material of the various collections made by Baeuerlen between 1884 and 1886 and the other relates to whether the 1886 collections were used in drawing up the protologue.

The only Baeuerlen sheet bearing both flowering and fruiting branchlets is *MEL1537921*, dated October 1886. The other seven sheets possess either flowering or fruiting branchlets, with *MEL1537922* bearing different branchlets with young and mature fruits, reflecting the two different collecting dates, as indicated by the November 1884 and February 1885 labels. The other specimens with mature fruit, on the sheets *Baeuerlen MEL1536165* and *Baeuerlen MEL1537921*, are apparently from the one collection, probably made in October 1886. Both have a few old flowers with the tepals lost, similar to other October collections made in more recent times; the fruits, clearly from the previous season by their maturity, have similar surface features and size, and unlike the rest of the series of collections, the leaves give the impression of having been crushed together, perhaps in packing.

Of the flowering material, George McRae's 1885 collection is at an earlier bud stage with sparser buds than the Baeuerlen collections. The Baeuerlen material could all have come from the one flowering specimen; although there is some variation in leaf colour the flowers are at a similar advanced bud stage. The fact that the flowers in Baeuerlen's specimens are still in bud, albeit at a late stage, makes it unlikely that they were collected in October as indicated on the three labels pertaining to the lectotype and isolectotype(s)), all annotated "Sources of the Clyde". Such a stage of flowering occurs in late August to September in the more recent collections of the species, flowering being well-advanced by October . Baeuerlen's September 1886 collection, sent to J.H. Maiden, is the only one of all the apparent duplicates which seems certain to be correctly labelled: it was the only material

possessed by Maiden and so not prone to the mixing that may have occurred in the MEL material.

It is likely, therefore, that Baeuerlen's flowering material was collected in September 1886 from Monga (or Sugarloaf Mountain: *Boorman NSW190748*) in the Budawang Range, south-east of Braidwood, and that Baeuerlen's fruiting material with a few scattered remnants of flowers was collected in October 1886 from "Near Mt Currockbilly", also in the Budawang Range. Baeuerlen made two earlier collections which were in fruit, one immature in November 1884, the other with mature fruit in February 1885, and both give the general locality "Braidwood District". MacRae's collection at an early bud stage was given a similarly general locality. These last collections may have come from areas south and west of Braidwood, perhaps mistakenly summarised by Mueller in the protologue as "near the eastern tributaries of the Snowy river" for neither the Shoalhaven nor the Clyde Rivers, which have the Budawang Range as their watershed, connect with the Snowy River.

Despite the proximity of the November 1886 date of publication of the protologue to the September and October 1886 dates of collection of some of the apparent syntypes, the syntypes *Baeuerlen 206* and *MacRae MEL1536164* are unlikely to have provided the sole basis of Mueller's descriptions. Only MacRae's bud material might have been available and it is too young. The buds in this specimen are moderately densely sericeous, whereas the inflorescence of the protologue is "almost glabrous" and a "petal" length is given, implying mature flowers were seen. The 1886 flowering material corresponds well in these aspects, having a few open flowers with sparsely pubescent tepals amongst the many mature buds. While there is perhaps some uncertainty that the fruiting material collected in October 1886 was not seen in drawing up the protologue, the flowering specimens, labelled as October 1886 but probably collected in September, appear to have been essential. Accordingly the copiously flowering specimen in MEL has been selected as the lectotype.

H. gibbosa (Sm.)Cav., Observ. Puerto Jackson, Anales Hist. Nat. 1 (1800) 214; Icon. 6 (1800) t.534.
Banksia gibbosa Sm. in J. White, J. Voy. Botany Bay N.S.Wales (1790) 224, t.22 fig. 2, basionym.
Conchium gibbosum (Sm.) Donn ex Sm. in Rees, Cycl. 9 (1807) no.1; Sm., Trans. Linn. Soc. 9 (1808) 119.
Conchium gibbosum, Donn, Hort. Cantabr., ed. 3 (1804) 21, nom. inval. (published without description or reference to basionym).
Type citation: None. *Lectotypus hic designatus*: t.22 fig.2 in the protologue. *Epitypus consociatus hic designatus*: *J. White s.n.*, 1793, New South Wales, LINN (herb. J.E. Smith no. 158.1, AD microfiche).

?H. pubescens Schrad. & J.C. Wendl., Sert. Hannov. (1798) 27, in note.
Type citation: none. *Syntypes*: none seen.

Conchium sphaeroideum Sm. in Rees, Cycl. 9 (1807) no.2.
Type citation: "Sent from Port Jackson with the preceding [*C. gibbosum*]" *Syntypes*: none seen.

Conchium cornutum Gaertn., Fruct. Sem. Pl. (Suppl. Carp.) 3 (1807) 216, t. 219.
Type citation: "In Nova Hollandia prope Port Jackson. Ex collectione Banksiana." *Syntypes*: *Banks & Solander s.n.*, 1770, New Holland, B (ex BM 25.iv.1911); none apparently in BM.

H. lanigera Tenore, Fl. Napolitana 1 (1811) 22, t.vi.
Type citation: "Questo bell'albero è coltivato da molti anni al Real Giardino di Caserta, d'onde è passato en quello delle piante, ...". *Syntypes*: none seen.

H. tamminensis C.A. Gardner, J.Roy.Soc.W.Austral. 47:57 (1964); W.R. Barker, Nuytsia 7 (1989) 1.
Type citation: "Hab. in distr. Avon prope Tammin in arenoso glareosis, fl. m. Julio-Aug., Gardner n. 11997". *Holotype*: PERTH.

Notes

1. Early records outside Australia include one from Montgomery in Africa in 1856 (*Martin G-DC*) and Norfolk Island in 1902 (*Maiden & Boorman NSW58172*), the latter as a hedge, the former with no further information. A record from Tammin, Western Australia (*Gardner 11997*) is either erroneous or the result of cultivation.

2. There is some doubt on the legitimacy of the basionym of *H. gibbosa.* In the protologue of *Banksia gibbosa* Smith (1790) was in two minds as to its conspecificity with *H. dactyloides*: "We suspect this to be the *Banksia dactyloides* of Gaertner, but if so his figure is by no means a good one; as he is generally very accurate, we are rather inclined to believe ours is a different plant and have therefore given it a new name". However, from this wording and by giving the plant a new name, Smith clearly decided that at least for the time *B. dactyloides* was different. He had accepted other Gaertner species, e.g. *B. pyriformis*, in the same paper. Under Article 34.2 of the ICBN relating to acceptance of names published with taxonomic doubt as validly published and Article 63 relating to illegitimacy of names through being superfluous, clearly *B. gibbosa* should be recognised as the earliest name for this species.

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GREVILLEA PAUCIFLORA R. BR. SSP. *LEPTOPHYLLA* (PROTEACEAE), A NEW SUBSPECIES FROM EYRE PENINSULA, SOUTH AUSTRALIA

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Abstract

G. pauciflora ssp. *leptophylla* circumscribes populations of plants with very slender subterete leaves drying mid green; they are confined to central Eyre Peninsula, South Australia and are closest allied to *G. pauciflora* ssp. *pauciflora*. Such leaves are population constant, although on the periphery of the area of distribution of the subspecies there is evidence of wider variation in the form of plants with leaves tending towards the narrow linear flat leaves of ssp. *pauciflora* which form part of the variation on plants of ssp. *pauciflora* on surrounding parts of Eyre Peninsula. In ssp. *pauciflora* and the two Western Australian subspecies leaves differ from ssp. *leptophylla* in drying grey-green and the leaf margins usually free from each other for their whole length or rarely contiguous for a small portion of their length.

This new subspecies of *Grevillea pauciflora* is described to make the name available for inclusion in the forthcoming treatment of the genus in the *Flora of Australia* (R.O. Makinson, in preparation) and to promote further consideration of its conservation status owing to clearing of its habitats in recent years.

The description provided is largely diagnostic, and has been put in the context of recent descriptions of *Grevillea* taxa in the *Flora of South Australia* (Barker 1986) and generic revisions (McGillivray 1993; Olde & Marriott 1995). Despite the removal of the new subspecies from *G. pauciflora* ssp. *pauciflora* in the latter two revisions, their descriptions of the ssp. *pauciflora* seem unlikely to need modification.

Grevillea pauciflora R. Br. ssp. **leptophylla** W.R. Barker, *ssp. nov.*

G. pauciflora R. Br. ssp. "*Narrow-leaved*" (*R. Bates 6936*): W.R. Barker, List Vasc. Pl. S. Austral. edn 4 (1993) 8.

G. pauciflora ssp. *pauciflora*: McGillivray, Grevillea, Prot.: taxonom. rev. (1993) 364, partly (as to linear leaved plants in NW of range); Olde & Marriott,, The Grevillea Book, 2 (1995) 84, partly (as to pl. 63B, a photo of plants collected by R. Bates from Cummins).

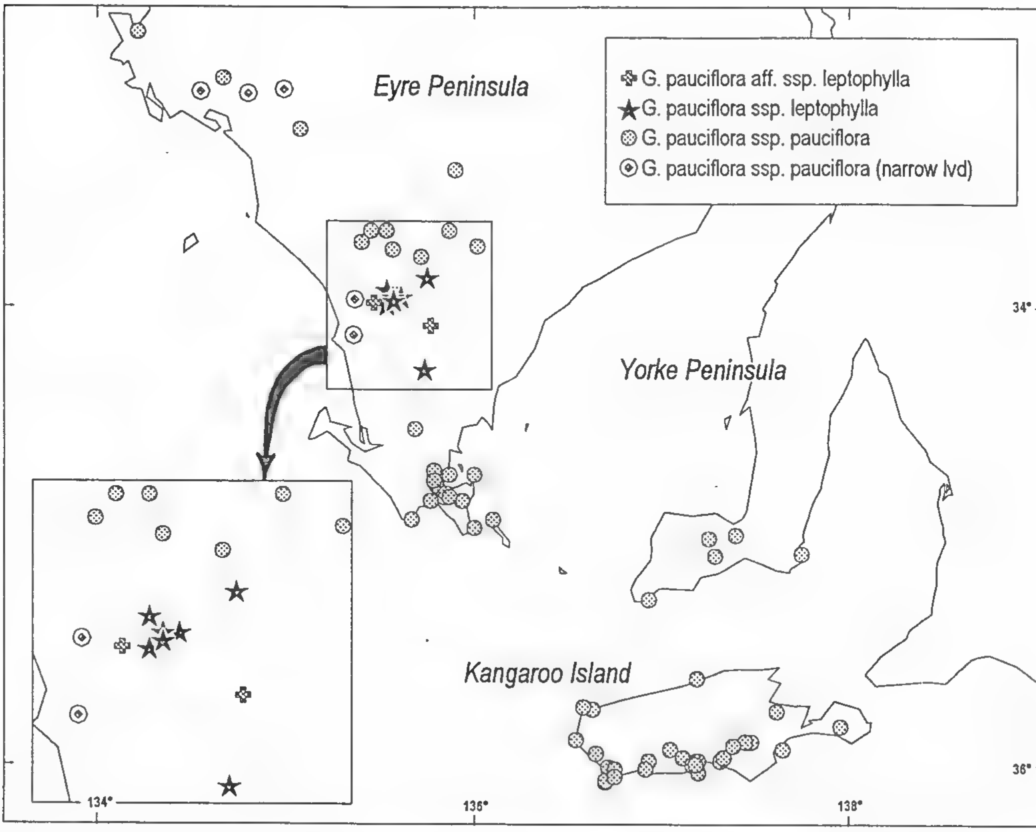
Plantis subspeciebus alteris *G. pauciflorae* foliis filiformibus, subteretibus, in sicco viridibus mediis, et areale distributionis in Paeninsulare Eyreo centrali differt.

Holotypus: *T. Hall 412*, 16.ix.1990, South Australia, Eyre Peninsula, Koolidie Station, NW of Yeelanna, along the road for 30 metres, growing in sand amongst limestone with *Melaleuca uncinata*, *Eucalyptus socialis*, etc., *Callitris* sp; spreading bush about 2 ft high,; leaves linear with recurved margins; flowers red; fruit elongated; population of 24 ranging in height from 1 ft [high] compact bushes up to 5 ft high spreading bushes; AD 99606322. *Isotypi*: CANB, NSW.

Branchlets ± round in cross-section; persistently densely raised tomentose, the hairs white on young shoots, turning grey. *Leaves* filiform, subterete, (1.0)2.0–4.0(5.5) cm long, (0.4)0.6–0.9(1.1) mm wide, flexible, densely brown-sericeous when young, quickly glabrescent but for the basally exposed lower side bearing dense appressed 2-armed hairs, the mature leaves deepish green, drying mid green, frequently in fresh material, consistently in dried with a single abaxial groove formed by the margins so recurved as to adjoin over their whole length except at the base. *Flowers* including the pedicels red, with a yellow style end and pollen-presenter; *pedicel* sparsely white-sericeous, the 2-armed hairs with ± appressed arms; *perianth* 5.5–6.0 mm long (unstraightened), externally with very sparse white-sericeous hairs on tube and base of limb, grading to dense at very apex of limb,

internally with dense woolly beard of white hairs c. 1.5–2 mm below the limb around the lower half of the style; *pistil* 7.5–8.5 mm long, the style 4.8–5.5 mm long, hardly exserted from the perianth. *Fruits* obliquely narrow ellipsoid, 12–13.5 mm long, c. 4 mm wide, the persistent style 5.2–6.0 mm long. (*Photograph*: pl. 63B: Olde & Marriott 1995, sub *G. pauciflora* ssp. *pauciflora*, the source of the style colour).

Distribution (Map 1): Confined to central Eyre Peninsula to the north and northwest of Cummins.



Map 1. Distribution of the subspecies of ***Grevillea pauciflora*** R. Br. in South Australia. (A full distribution of the species, which extends into southern Western Australia, is shown in McGillivray 1993).

Ecology: The subspecies occupies scattered shrubbery in the calcareous *Eucalyptus* mallee woodland which characterises the Kappawanta Environmental Assocation of Laut et al. (1977) from which most collections have been made. It also has been located in the Yeelanna Environmental Assocation (*Bates 6936*) which is a largely cleared calcrete plain with remnant roadside vegetation.

Conservation status

The subspecies is known from several localities. At present up to 24 plants have been located in the type locality. This one locality seen is in an area of extensive bush which could be subject to clearance applications. Two searches for the plant, including one by the author in 1995, for a further locality north of Cummins (*Bates 6936*), where the plant was found nine years earlier, have been unsuccesful. Other locations, collected by T. Croft and R. Barrat, have been subject to clearance applications. A conservation category of 2R (following Leigh, Briggs & Hartley 1981), is suggested for the plant. However, field

surveys are needed in the area and the category is dependent on the pressure clearing has on populations.

Notes

The plant has all the characters which distinguish *G. pauciflora* from its relatives, as cited in McGillivray (1993) and Olde & Marriott (1995). In particular the pistil in *G. pauciflora* ssp. *leptophylla* is similarly short and hardly exceeding the perianth. It is much longer and greatly exceeding the perianth in allied species such as *G. sparsiflora* F. Mueller and *G. oligantha* F. Muell.

This taxon was informally recognised by the author (Barker 1993) as distinct amongst South Australian representatives of *G. pauciflora* ssp. *pauciflora* on the basis of its narrower, filiform, subterete leaves (Table 1). Its leaves also differ from ssp. *pauciflora* in drying mid green; the upper surface of the leaves of ssp. *pauciflora* dry a grey-green colour. The plant is given formal taxonomic recognition owing to its separate range of distribution and population constancy of its morphological features. It is given subspecific rank within *G. pauciflora* because it is currently only distinguished on a few leaf characters.

Table 1: Some morphological differences between the subspecies of ***G. pauciflora***: ssp. ***pauciflora***, ssp. ***leptophylla***, ssp. ***saxatilis*** and ssp. ***psilophylla***. The perianth measurement is taken from McGillivray 1993 for all but ssp. ***leptophylla***.

Character	Ssp. *pauciflora*		Ssp. *leptophylla*	Ssp. *saxatilis*	Ssp. *psilophylla*
	Normal width leaves	Narrow leaved populations			
Branchlets	rounded	rounded	rounded	longitudinally ribbed	longitudinally ribbed
Leaves					
shape	broad obovate to ...	... narrow linear	filiform	narrow linear	narrow obovate
width	(2.0)2.5–8(12) mm	(1.0)1.2–2.0(2.5) mm	(0.4)0.6–0.9(1.1) mm	(1.2)1.5–2.5(4.2) mm	2.9–7.8 mm
rigidity	rigid	rigid	flexible	rigid	rigid
indumentum on abaxial side	sericeous	sericeous	sericeous	sericeous	glabrous
longitudinal venation	obscure, not continuous over great lengths	obscure, not continuous over great lengths	obscure, not continuous over great lengths	often prominent continuous over ± whole leaf length	obscure, not continuous lengths
Perianth distance from beard to ventral limb base	1–2 mm	1–2 mm	1.5–2 mm	c. 0.6 mm	c. 0.2 mm
Distribution	SA (ep, yp, ki)	SA (ep)	SA (ep)	WA	WA

The new subspecies shares differences from the Western Australian subspecies, ssp. *psilophylla* McGillivray and ssp. *saxatilis* McGillivray, with the other South Australian subspecies, ssp. *pauciflora* (Table 1): its rounded branchlets, the extensive (1.5–2 mm) glabrous area between the base of the perianth limb and the woolly beard inside the tepals.

Several collections of *G. pauciflora* on Eyre Peninsula outside of the range of distribution of ssp. *leptophylla* have narrow linear flat leaves which are not quite as fine as in ssp. *leptophylla,* nor are the margins as close. They also have dried grey-green as characterises ssp. *pauciflora.* In most collections leaves vary in width on each branch, with width attaining 2.0-2.5 mm. These are considered to be narrow leaved forms of ssp. *pauciflora.* In two instances from locations closest to the range of distribution of ssp. *leptophylla* (*Croft AD99606319p.p.*, *Alcock 2673*) the leaf width of (0.9)1.0–1.4 mm is more constant and intermediate between ssp. *leptophylla* and the narrow leaved forms of ssp. *pauciflora.* The former collection contains a broad-leaved specimen of ssp. *pauciflora.* Croft (*AD99606319*)

noted that broad-leaved plants were in full flower, while the narrow-leaved plant was not flowering. While this may indicate phenological barriers to intergradation, these narrow-leaved plants may either be extremes of variation on the margins of the area of distribution of ssp. *leptophylla* or indicate some more complex intergradation between the two subspecies.

Plants of *G. pauciflora* with narrow linear leaves were noted in the recent revisions of McGillivray (1993) and Olde & Marriott (1995), the former noting that the characteristic being confined to the northwest of the range of the subspecies, presumably referring to parts of Eyre Peninsula. However, aside from the extremes of ssp. *pauciflora* with narrow linear leaves noted above, Olde & Marriott probably only saw a photograph of *Bates 6936*, while McGillivray may only have seen the intermediate-leaved collection *Alcock 2673*.

While there is sufficient evidence as to the distinctness of this taxon, further field work is required to establish if there is any intergradation between ssp. *leptophylla* and ssp. *pauciflora* and whether there are ecological and further morphological differences.

Additional and selected specimens examined:

Grevillea pauciflora R. Br. ssp. *leptophylla* W.R. Barker

SOUTH AUSTRALIA. **Eyre Peninsula**: *W.R. Barker 7596 & R.M. Barker*, 8.x.1995, On track to 'Koolidie' and Mt Cora, c. 6.3 km by road N of the junction near the Mitchell Telephone Exchange on Mitshan Road, c. 26 km direct NWof Yeelanna, AD (several duplicates for distribution; topotype); *R. Barrat s.n.*, 13.ix.1991, 33 km S of Lock, Section 53, Hundred of Shannon, AD99146022; *R. Bates 6936*, 31.viii.1986, 10 km N of Cummins, AD, CAF; *T. Croft s.n.*, 1.x.1990, C. 18 km NE of Mount Hope; Section 45, Hundred of Mitchell, AD99050229; *T. Croft s.n.*, 30.xi.1990, Section 26, Hundred of Shannon, AD99050221; *T. Croft s.n.*, 11.iv.1991, 25 km NW of Yeelanna; Section 46, Hundred of Mitchell, AD99606320.

Grevillea pauciflora R. Br.; specimens with affinities to ssp. *leptophylla* W.R. Barker

SOUTH AUSTRALIA. **Eyre Peninsula**: *C.R. Alcock 2673*, 24.vii.1968, E side of Sec[tion] 51, H[undre]d of Shannon, AD (2 sheets; n.v.: SI, NT, LSU, MA, MO, TAI, TUR); *T. Croft s.n.*, 10.iv.1991, 30 km NW of Yeelanna; Section 43, Hundred of Mitchell, AD99606319, p.p.;

Grevillea pauciflora R. Br. ssp. *pauciflora*; forms with narrow linear leaves:

SOUTH AUSTRALIA. **Eyre Peninsula**: *C.R. Alcock 2761*, 17.ix.1969, H[undre]d Kiana, roadside abutting Sec[tion] 45; *L. Beck per T. Dennis 11*, without specific locality, AD; *J.B. Cleland s.n.*, 23.ix.1957, Between Streaky Bay and Talia, AD966080119, AD97710927 (n.v.: TI, TUR); ; *T. Croft s.n.*, 17.x.1990, Section 57, Hundred of Witera, AD99110248; *T. Croft 9*, 31.v.1991, 2 km S of Mt Hope, AD; *T. Fuhbohm KULL30*, 24.vii.1989, Kulliparu Cons. Pk., NW corner, AD; .

Grevillea pauciflora R. Br. ssp. *pauciflora*; selected other collections:

SOUTH AUSTRALIA. **Eyre Peninsula:** *R. Brown s.n.*, 1802-5, Bay X, So[uth] Coast & Bay I."*Grevillea pauciflora* Br" (label in Brown's hand), MEL68731 (probable syntype: McGillivray 1993); *J.S. Browne 15*, 1874, Port Lincoln, MEL68746; *Hj. Eichler 19306*, 6.x.1967, Hundred of Blesing, c. 6½ km ENE of Bascombe Well Homestead, at track along eastern boundary fence, AD; *M.L. Evans 70*, 26.viii.1980, 45 km from Minnipa on the Mt Damper road, AD; *Dr Elizabeth Turner s.n.*, 3.ix.1963, C. 8 miles (12 km) NW of Port Kenny, MEL68730; *Warburton s.n.*, s.dat., Spencer's Gulf, MEL68743; *C. Wilhelmi s.n.*, s.dat., Near Lake Hamilton and Marble-Ranges, MEL68741, MEL68745; *C. Wilhelmi s.n.*, s.dat., Coffin Bay, MEL68744. **Yorke Peninsula:** *M. Kenny s.n.*, 14.x.1971, Edithburgh, AD97147105; *K.B. Warnes 45*, 23.ix.1972, Between Warooka and Stenhouse Bay, c. 40 km from South Bay, AD. **Kangaroo Island**: *E.N.S. Jackson 4375*, 22.viii.1982, Flinders Chase Nat. Pk., just W of Yacca Flat on road to Remarkable Rocks, c. 10 km S by road from 'Rocky River' Homestead, AD; *O. Tepper s.n.*, 13.xi.1886, Mt Taylor, MEL68740 p.p; *O. Tepper s.n.*, 1886, Mouth of Stunsail Boom R., MEL68740, p.p.

Grevillea pauciflora R. Br. ssp. *psilophylla* McGillivray

WESTERN AUSTRALIA: *Anon. s.n.*, 8 Oct, South end Russell ranges, MEL68732; *Anon. s.n.*, s.dat., Low round granite hills, S.West end Russ[e]ll Range, 2 ft., MEL68738 p.p.; *D.J. McGillivray 3601 & A.S. George*, 30.vi.1976, On Fisheries Road, opposite "Aroona" Station, E of Esperance, PERTH; *R.D. Royce 10065*, 4.xii.1971, W edge of Cape Arid National Park, along Balladonia Road, S of Mt Ragged, PERTH.

Grevillea pauciflora R. Br. ssp. *saxatilis* McGillivray

WESTERN AUSTRALIA: *M.I.H. Brooker B4504*, 10.iv.1974, Tower Hill, Mt Ragged, PERTH; *Miss Chopin*, vii.1938, Thomas River, PERTH; *A.S. George 16130*, 17.iv.1980, Below summit of Tower Peak, PERTH.

Grevillea oligantha F. Muell.

WESTERN AUSTRALIA: *J.B. Cleland s.n.*, 12.ix.1950, C. 55 km N of Esperance, AD 97310195; *R.J. Cranfield 986*, 65 km S of Gnowangerup, MEL597156 (ex PERTH); *R. Filson 9280*, 8.x.1966, 1 mile W of Thistle Bay, 36 miles E of Esperance, MEL648448; *R.A. Saffrey 294*, 7 Aug. 1968, 22.5 km E of Mount Madden at cross roads ... E of Lake King, AD (ex PERTH); *P. Wilson 3013*, 12.ix.1964, C. 48 km N of Esperance, AD.

Grevillea sparsiflora F. Muell.

WESTERN AUSTRALIA: *Anon. s.n.*, s.dat., Cape Arid, MEL74751 (paralectotype); *Miss S. Brooke s.n.*, 1887, Near Israelite Bay, MEL74752, MEL74753; [*Maxwell*] *s.n.*, Near Eyres relief, Sand plains,Cape Arid, MEL74750 (comprising lectotype and 2 paralectotypes); *R. Parsons 140*, 1.xii.1967, C. 18 km SSW of Cocklebiddy, AD (ex MELU); *R. Parsons 175*, 2.xii.1967, On clifftop on coast S of Caiguna, AD (ex MELU).

Acknowledgements

Mr Tim Croft of the Native Vegetation Management Branch of the Department of Environment and Natural Resources is thanked for making his important collections which extended the distibutional range of the plant. I am also grateful to Mr Bob Makinson of the Australian National Herbarium for encouraging me to describe the new plant. He and the editors are also thanked for comments on the manuscript.

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J. Adelaide Bot. Gard. 17: 217–221 72263

TAXONOMIC STUDIES IN *EUPHRASIA* L. (SCROPHULARIACEAE). VII. A NEW SPECIES AND A WIDELY DISJUNCT POPULATION FROM SOUTH-EASTERN TASMANIA

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Abstract

A new species *E. fragosa* from south-eastern Tasmania restricted to two sites near Southport and on south Bruny Island on either side of the D'Entrecasteaux Channel is formally described. It belongs to Sect. *Striatae* and is closely allied to *E. striata* and *E. semipicta*. It is endangered owing to its being known from two populations with limited numbers of plants. An outlying population of *E. collina* ssp. *diemenica* confined to the summit of a small mountain on the Tasman Peninsula is identified.

As a result of an opportunity provided by the Parks and Wildlife Service, Department of Environment and Land Management in Tasmania to see plants in the field, it is now possible to clarify the taxonomy of two taxa of *Euphrasia* for which previously there had been inadequate information.

This paper is part of continuing revisional research by the author into the genus (for previous papers see Barker 1987; also Barker, Kiehn & Vitek 1988). The paper also contributes to a series of studies by the Tasmanian Parks and Wildlife Service supported by funding from the Australian Nature Conservation Agency aimed at providing a solid information base for development of management plans of rare and threatened *Euphrasia* taxa in south-eastern Tasmania.

A new species from Southport and Bruny Island previously recognised informally

In 1982 several herbarium specimens were recognised informally by the author (Barker 1982) under the phrase name *E.* sp. *"Southport"* as a likely new species intermediate morphologically between *E. striata* R.Br. and *E. semipicta* W.R.Barker. Dr Winifred Curtis in 1958 had collected one or two plants from the area of the original specimens collected near Southport over a century earlier. No other specimens existed. Subsequently, in 1986 Mr Phil Collier made further collections, locating the plant across D'Entrecasteaux Channel on South Bruny Island (Collier 1990). Through examination of the plant in the field by the author in late 1995, which established the variability of the various diagnostic characters and absence of intergradation with related species, the species can be now formally named and a more complete description of its variability given.

Euphrasia fragosa W.R. Barker, *sp. nov.*

E. sp. *"Southport"*: W.R.Barker, J. Adelaide Bot.Gard. 5 (1982) 139, f. 45.

Species nova Sectionis *Striatae*, absentia indumenti glandulosi *E. striatae* et *E. semipictae* affinis, sed a duo dentibus foliorum paucioribus, in corolla cucullo angustiore fissura breviore, labio inferiore minore, antherisque aristis posticis brevibus, et ab *E. striata* ramificatione super terram, internodiis, saepe longioribus, tubo corollae breviore, apice capsulae angustiore seminibusque minoribus differt.

Holotypus: *W.R. Barker 7678 & W. Potts*, 10.xii.1996, 'Seaview', a property at the entry of Southport bay, west of Point Rossel, c. 3 km E of Hythe. Locally common, on vehicular and cattle tracks or other open sites with fine grasses and small herbs, on south facing clayey slope under *Eucalyptus tenuiramis* open forest burnt some years prior, with very open shrubbery of *Leptospermum scoparium, Melaleuca squarrosus* over *Gahnia grandis, Lomandra, Gleichenia.* Erect perennial herb to c. 25 cm high. Corolla mid blue-purple with white mouth, consistently extensively red-purple striated on all 3 lobes and in hood, with yellow spot, sometimes faint, on lower side of mouth. Single specimen per plant collected. AD. *Isotypi*: HO, other duplicates for distribution.

Perennial *herb*, 16.5-32 cm tall, apparently in first year with a single erect stem bearing axillary shoots and ascending to erect branches in lower aerial parts, dying back to uppermost branches after first year. *Stem* bearing inflorescence in first year, 13.5–28 cm high to its base, bearing 17–26 pairs of leaves, often branched with uppermost branches or shoots reaching to c. 3–6 nodes below inflorescence, sometimes simple; *internodes* between uppermost (3) 4–8 (10) leaf pairs longer than leaves, the longest internode (2.5) 3–6 times length of uppermost leaves, in lower parts much shorter than leaves; axes purple-brown with 2 bands of moderately dense retrorse white eglandular hairs (0.05) 0.1 (0.15) mm long. *Leaves*: uppermost leaves of flowering stem or main inflorescence-bearing branch (5.0) 5.5–10.0 (10.7) mm long, in outline obovate (2.4) 3.1–5.0 (5.2) mm wide, green, sometimes reddened in parts, glabrous but for tiny scaberulous eglandular hairs on the adaxial surface of the apical tooth and sessile gland patches on the lower side confined to distal (0.35) 0.40–0.55 of lower surface; *base* long attenuate; *teeth* 1 pair, rarely a second tooth down one margin, bluntly to sharply acute, confined to distal (0.15) 0.20–0.30 (0.40) of leaf, with longest tooth (0.45) 0.7–1.7 (2.0) mm long; *apical tooth* bluntly obtuse to acute, rarely almost caudate, (1.1) 1.4–2.5 (2.9) × (1.1) 1.4–2.2 (2.5) mm; leaves *lower down* and those on branches of similar shape, but slightly smaller, much smaller on shoots. *Inflorescences* but for lowermost 0–3 nodes dense, that of main axes bearing c. 14–25 or more flowers, with lowest nodes sometimes bearing one flower, those on lateral branches with fewer flowers; *rachis* as for axes; *internodes* longer at lower nodes possibly elongating slightly after anthesis; *pedicels* of lowest flowers c. 1–4 mm long, shorter towards apex; *apical bud cluster* excluding buds rounded-conical, initially 0.6–2.2 cm long, becoming hidden by corollas of uppermost flower pair at first 2–4 nodes. *Bracts* similar to uppermost leaves. *Calyx* 4.7–5.5 mm long, 4-ribbed, externally glabrous, internally glabrous but for very short eglandular hairs inside teeth, extending onto margins; *teeth* bluntly to sharply acute; *lateral clefts* 1.4–1.8 mm deep, shorter than *median clefts*, which are c. 2.2–2.5 mm deep. *Corolla* 8.0–9.0 mm long along upper side, mid to deep blue-purple outside and inside, with a white mouth inside; the lower lobes and hood deep red-purple striated, each to be usually with 3 striations, the lowest sometimes with just a single striation, with a yellow spot, rarely faint on the lower side of the mouth; *tube* 4.7–5.5 mm long abaxially and laterally broadened at about point of insertion of anterior filaments, which are 4.0–5.0 mm from base of corolla, externally glabrous, except for very short glandular hairs at point of insertion of anterior filaments; *hood* 2.5–2.8 mm long, excluding lobes 2.5–3.0 mm wide, including lobes c. 3.0 mm wide, externally moderately densely eglandular hairy; *upper lobes* ± in same plane, facing forwards, shallowly emarginate, with cleft between 0.7–1.0 mm deep; *lower lip* concave from above, downturned from base, 2.6–4.0 × c. 7.5 mm, externally glabrous but for scattered eglandular hairs; *lower lobes* emarginate, the lateral ones c. 2.0–2.2 mm wide, clefts between 1.6–1.9 mm deep. *Stamens* with filaments glabrous, the anterior pair 2.8–3.5 mm long, the posterior pair c. 1.5–1.6 mm long; *anthers* 1.4–1.5 x 0.8–1.0 mm, with area around *connectives* glabrous, with *slits* lined by short to moderately long eglandular hairs, with rearmost pair of *awns* 0.2–0.3 mm long, longer than other three pairs which are 0.1(0.15) mm long. *Ovary* in lateral view ovate-elliptic, slightly compressed laterally, in median view ovate, glabrous but for a few setae on apex; apex in lateral view obtuse; *ovules* c. 70–80. *Capsules* 7.3–9.0 mm long, compressed laterally, in lateral view elliptic 2.2–3.2 mm broad, in median view ovate to ovate-acuminate, glabrous but for few to several, sparse to moderately dense, short setae at very apex; *apex* in lateral view obtuse or obliquely so. *Seeds* (mostly young seen) c. 25–45, obliquely broad ellipsoid, 0.65–0.9 (?1.4) mm long, 0.4–0.6 mm wide.

Distribution (Map 1) *and ecology*

The species is known from south-east Tasmania in two locations about 7 km apart on either side of a water barrier the D'Entrecasteaux Channel, at the northern headland of the bay Southport and on Mt Bleak on Labillardiere Peninsula, South Bruny Island.

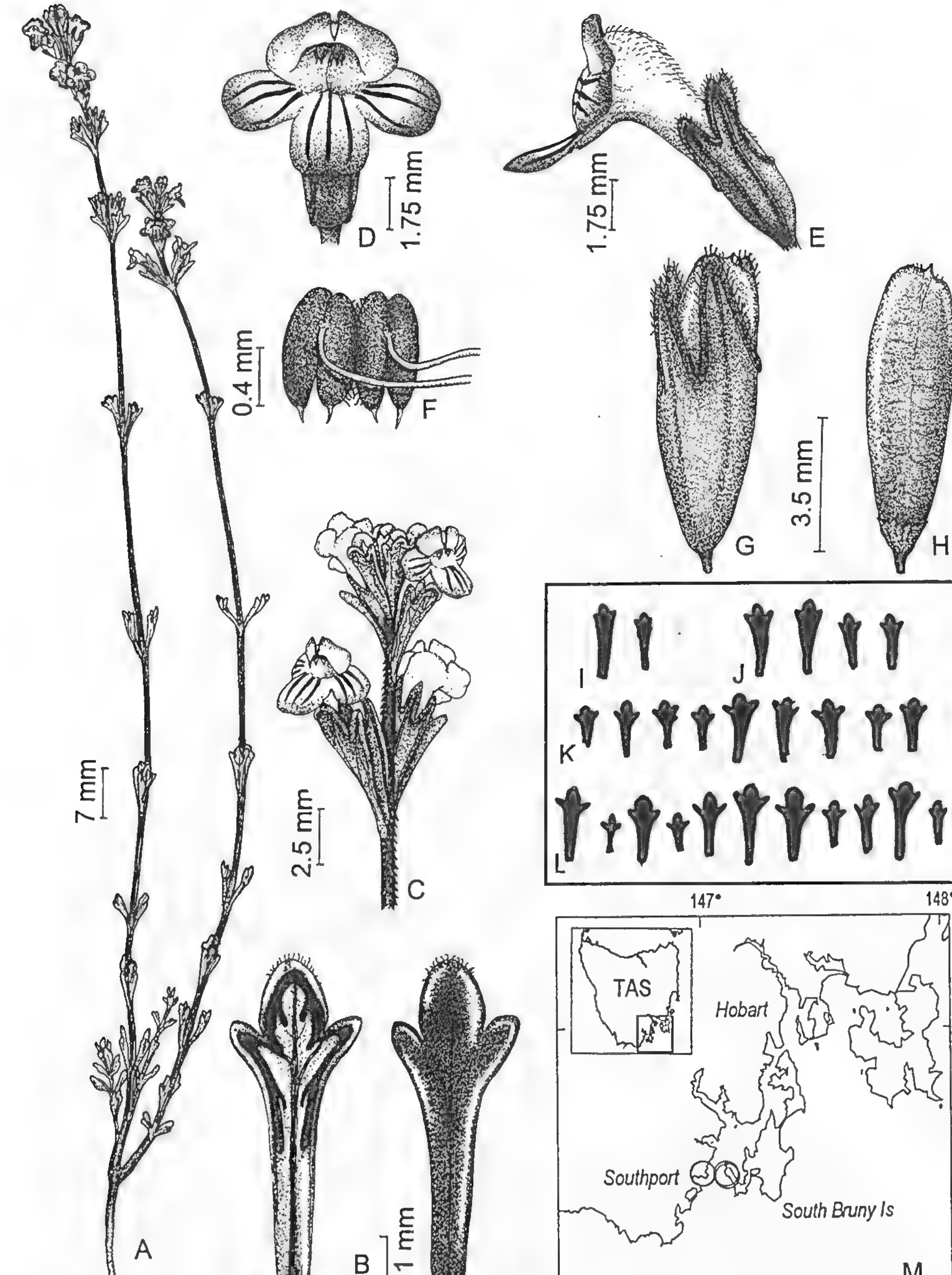

Fig. 1. ***Euphrasia fragosa*** W.R. Barker. A, habit; B, upper stem leaf (abaxial and adaxial view); C, inflorescence, D–E, flower front and side view; F, stamens outer surface, lateral view; G, fruit, lateral view; H, capsule, calyx removed (A–F, *Barker 7677*, plant 3; G–H, *Barker 7678*, plant 6; del. G. Dashorst). I–L, uppermost leaves on main inflorescence subtending branch, actual size (I, *Barker 7666*; J, *Barker 7667*; K, *Barker 7677*, L, *Barker 7678*). M, distribution in south-east Tasmania.

It occurs in open sites with small herbs and fine grasses disturbed by proximity to vehicular or animal tracks, in the former location in open *Eucalyptus* forest with open shrubbery, in the latter in open woodland or adjoining dense shrubbery. The locations had been subjected to fire some years before.

Conservation status

E. fragosa occurs on land under reservation on the Labillardiere Peninsula, but this is the smaller of the populations and may be questionably viable in the long term. In the Southport location plants are more abundant, but the minimum population size for long term viability is unknown and one of the two known populations is threatened by development of a resort (W. Potts, pers. comm. 1995, 1996). As a result a status of 2Ec is suggested, following the classification of Leigh, Briggs & Hartley (1981). Dr W. Potts is researching various aspects of the biology of the species with the view to developing a management plan for its conservation.

Notes

1. *E. fragosa* belongs with Sect. *Striatae* by its striated flowers and glabrous anther backs. Through the lack of glandular hairs on its branches, leaves, rhachis and calyx and short toothed leaves it is closest allied to *E. striata* and *E. semipicta*. It differs from both species by its on average fewer leaf teeth, in the corolla by its narrower hood with shorter cleft between the upper lobes and smaller lower lip and by its shorter rearmost anther awns. It also differs from *E. striata* by its branching above ground level, its often longer internodes, its shorter corolla tube, its narrower capsule apex and its smaller seeds. Within the variable *E. semipicta* (Barker 1982) it is closest allied to the forms with white corollas and glabrous or sparingly hairy anther backs.
2. The species epithet derives from the Latin adjective *fragosus*, meaning fragile or broken, alluding to three characteristics of the plant: its delicate habit, its vulnerability in the face of human activities, and its disjunct range of distribution.

Further specimens examined

TASMANIA. ***East Coast***: *W.R. Barker 7666 & W. Potts*, 8.xii.1996, Labillardiere Peninsula State Reserve, South Bruny Island, E slopes of Mt Bleak, AD, HO; *W.R. Barker 7667 & W. Potts*, 8.xii.1996, Labillardiere Peninsula State Reserve, South Bruny Island, W facing upper slopes of Mt Bleak, AD, HO. ***South West***: *W.R. Barker 7677 & W. Potts*, 10.xii.1996, 'Seaview', a property on at the entry of Southport bay, west of Point Rossel, c. 2.5 km E of Hythe, AD, HO; *P. Collier 1823*, 8.xi.1986, Labillardiere Peninsula, South Bruny Island, HO; *W. Curtis s.n.*, 5.xii.1958, Southport, HO; [*Stuart 1744*], xii.1855, South Port, MEL41437 p.p.; *Stuart 1744 (p.p.)*, xii.1856, South Port, MEL41450 p.p.

A widely disjunct Tasman Peninsula population of *E. collina* R.Br. ssp. *diemenica* (Spreng.)W.R.Barker

Two collections by Allan and Moscal from Mt Brown on West Arthur Head at the entrance of Port Arthur on Tasman Peninsula with densely hairy anther backs in the past have been questionably determined by the author as *E. semipicta* or *E. collina* in the absence of data on the variation in anther indumentum and in corolla coloration. Examination of the extensive population confined to the summit showed it to be *E. collina* by the lack of striations marking the corollas and the consistently densely hairy anther backs. It falls within circumscription of ssp. *diemenica* by the lack of branching above ground level, the leaves with a single pair of short teeth and the limited extent of the lateral branches of the sessile gland patches. This subspecies is highly polymorphic with ecotypic and geographical races evident (Barker 1982). The relationships of the Mt Brown population should be determined in the context of a revision of the ssp. *diemenica*.

This restricted population occurs 60 km south-east of the nearest locations of *E. collina* ssp. *diemenica* on the summit area of Mt Wellington and is in a State Reserve. Taking into

account the alpine and subalpine habitats of ssp. *diemenica* elsewhere, its highly exposed windswept situation may be important to its survival.

Specimens examined

TASMANIA. *East Coast*: *M. Allan s.n.*, s.dat., Brown Mtn, HO35092; *W.R. Barker 7672 & W.Potts*, 9.xii.1995, On W lower end of summit ridge of Mt Brown, AD, HO (dupl. for distribution); *W.R. Barker 7676 & W. Potts*, 9.xii.1995, Summit of Mt Brown, c. 30 m W of trig point, AD, HO (dupl. for distribution); *A. Moscal 4635*, s.dat., Mount Brown, HO401919; *B. Potts & G. Jordan per W.R. Barker 7673*, 9.xii.1995, On SW extension of summit of Mt Brown, AD, HO.

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I am grateful to: Dr Stephen Harris of the Tasmanian Department of Environment and Land Management for provision of air fares to enable field studies of these taxa; Mr Gilbert Dashorst for his illustration; Mr Phil Collier for his communication of specimens resulting from his discoveries and rediscoveries of new and previously known populations of the rare species of south-eastern Tasmania; the Tasmanian Herbarium for provision of specimens, collecting requirements and research facilities; Mrs Ros Hirth for assistance with recording measurements of some of the characters. In particular, Dr Wendy Potts of the Tasmanian Department of Environment and Land Management is thanked for encouragement to undertake the work, guidance to field sites, and, with her husband Brad, a fortnight's welcome hospitality.

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J. Adelaide Bot. Gard. 17 223–225 (1996)

BOOK REVIEWS

Flora of Australia Volume 55, Lichens—Lecanorales 2, Parmeliaceae, Australian Biological Resources Study, Canberra (1994)

This volume, the second describing lichens and thus only the second volume to deal with non-angiosperm groups, presents a fine example for publications on cryptogamic botany (deference to purist mycologists aside, perhaps we can still include lichens in the field of botany). It is even able to stand with some equality among angiosperm taxonomic volumes, whereas many publications dealing with cryptogam taxonomy exhibit considerable shortcomings. There are, in fact, drawbacks to be considered with the cryptogam volumes of *Flora of Australia*, but some are not immediately obvious and all are probably unavoidable in Australia at present, for a variety of scientific and economic reasons. Cryptogam taxonomy in Australia is poorly understood, much more than angiosperm taxonomy, which itself is still considerably behind an ideal world standard in many areas. Almost total lack of funding has led for decades to a lack of researchers, which often has resulted in enthusiastic but poorly trained "amateur" taxonomists (which can include professional botanists trained in non-taxonomic fields), doing what little work has been done. Hence, the standard of knowledge expressed within the cryptogam volumes of *Flora of Australia* must inevitably be lower in many areas than that for the angiosperm volumes. The much greater time needed for microscopic examination of minute specimens will inevitably be reflected in smaller numbers of specimens being examined for treatments needed by a deadline. In many cases the quantity of specimens does not even exist, due to the lack of collectors with "trained eyes" for cryptogam taxa, or the specimens may be buried within unidentified backlogs in herbaria. Since the manuscripts will have been edited to the high and consistent standards of *Flora of Australia*, much of this inadequacy will not be apparent, but it is nevertheless true that the cryptogam volumes can only be "state of the art" and thus more or less preliminary in nature.

These comments aside, Volume 55 exhibits mainly results from a researcher of high standard with considerable experience in the groups described. Professor Jack Elix has become an eminent authority on Parmeliaceae in Australia due to years of painstaking examination of much material of the group, in both the field and the chemistry laboratory. The impression is gained that this broader and more complete knowledge has resulted in a more practical and useable treatment of these taxa than perhaps may be said for some groups in the first *Flora of Australia* lichen volume. Prof. Elix's keys seem to be aimed at practical, not pure academic, use and generally utilise characters and tools which may reasonably be expected to be available even to the interested amateur, not absolutely requiring use of techniques such as thin layer chromatography to separate species. Where more advanced chemical knowledge is used in keys, it appears always to be used as a secondary or supportive character. It is of concern that an apparently increasing level of what passes for contemporary lichen taxonomy seems based almost purely on chemical microspeciation and less practical authors than Prof. Elix have almost removed the ability to identify certain lichen genera even for those with expertise and only basic herbarium facilities, let alone the interested amateur.

The addition in this treatment of a synoptic key to genera of Parmeliaceae is a helpful and fresh approach to a complex family, giving added possibilities for identification and for comparisons at a broader level. The introductory and explanatory sections are helpful and clearly expressed. Whilst the 150 species of *Xanthoparmelia* (the largest lichen genus in Australia) may still be daunting to separate, it is likely no greater experience can or will be brought to bear upon this group in Australia for a very long time!

If the appearance of these first cryptogam volumes of *Flora of Australia* were to serve no other function than to draw together a basic coverage of known taxa and provide keys for them, a valuable service would have been performed. As for this volume, a substantially better result than that seems to have eventuated.

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Welcome innovations in the first of two *Flora of Australia* Proteaceae volumes

Flora of Australia Vol. 16: Elaeagnaceae, Proteaceae 1. Available from CSIRO Publishing in hardcover (AUS$79.95 in Australia or New Zealand, US$79.95 elsewhere) or softcover (AUS$64.95 and US$64.95, respectively). Add $6 for postage and handling if purchased direct from CSIRO.

Apart from the small family Elaeagnaceae, this newest volume of the *Flora of Australia*, the seventieth overall since 1981 and the twelfth of 47 on the higher plants of the continent itself, is given over to one family. The publication of the first volume of treatment of the Proteaceae will, with the imminent completion of its companion volume 17, herald the first of Australia's six largest flowering plant families to be covered by the *Flora* programme (Compositae, Cyperaceae, Leguminosae s.lat., Myrtaceae and Gramineae are the others). This volume deals with 42 of the family's 46 Australian genera and roughly half of its 1100 species. *Grevillea*, *Hakea*, *Banksia* and *Dryandra* remain for volume 17.

A welcome first for *Flora* users is the series of brief introductory reviews. The first covers developments in the higher classification of the family and its relationships. Evidence is accumulating for the family's early origin amongst the flowering plants and long isolation and diversification. The bulk of the diversity in the family seems represented in Australia, but the biogeography could have been more readily apparent by inclusion in the tabulated synopsis. Two new subfamilies are described bringing the number of monotypic Australian subfamilies to four. The other tribes, the diverse and often specialised Proteoideae and Grevilleoideae and the Persoonioideae, less diverse but with primitive features, extend out of the continent. Morphological variation within each tribe or subtribe to a genus level, and in leaves, inflorescences, floral and fruit organs is also briefly reviewed, as well as dispersal (all too brief), pollination (too much on insects and specific examples, too little on floral syndromes, inadequately scotched as a phenomenon, or the species visited by the insects) and utilisation. These chapters would have benefited from recruitment of other specialists and of cross-referencing to significant references in the body of the *Flora* (e.g. resprouting ability of many species, at times inconsistently given, and the trigger pollination mechanism in *Synaphaea*). Some obscure terms are not in the glossary, including *crepuscular*, *innocuous* (refers generally to harmless: far better specify what is lacking, particularly as we are told that many Proteaceae are poisonous), *oligotrophic* (as to soils: why not *poor*?). Such terms needed in the reviews should be defined there (in brackets) for ease of reading.

The several largest genera treated (*Persoonia, Isopogon, Petrophile, Conospermum, Synaphaea, Adenanthos*) are, apart from the first, most diverse in southwestern Australia; the eastern and northern genera have fewer species. Many new species and three new genera (including the possible "living fossil" *Eidothea* and the brazen *Megahertzia*) are described. The identification keys appear good in providing correlated characters at leads, though of course they are generally dependent on complete material. May the developing practice of devising computerised multiple entry keys become a norm! Descriptive information in the *Flora* is still limited; for example, what does the fruit of *Adenanthos* look

like? Nevertheless, this volume of the *Flora* has a solid feel to it through the introductory review and recent innovations of increased discussion and sometimes description length (above the arbitrary and prohibitive 100 words or much less of the past) and the narrower blank margins around a closer text. Detailed discussion in the main flora text, e.g. under *Persoonia gunnii*, is a refreshing response to editorial requests, adding considerably to the *Flora*'s usefulness and interest, but perhaps reducing even more the chances for publication of the much-needed monographic detail in these groups. Line drawings are of generally a high order as are the colour photographs, with increased clarity through use of flash. However, the editors could consider a consistent series of line drawings, by the one artist in consultation with specialists, to facilitate diagnostic comparisons between genera.

Noteworthy from surveying the distribution maps is the preponderance of species confined to small areas of the continent; very few are widespread. However, the inconsistency in presentation, with dot points in some genera representing grid squares, e.g. in *Persoonia*, in others localities, led to misconceptions of relative abundance.

There are 45 contributors to the volume. Of the authors of the various treatments most are staff of herbaria and universities and it is welcome that a similar level of input by these institutions over the history of the *Flora of Australia* is now being mentioned in the acknowledgements of each volume. But can this support continue indefinitely from herbaria struggling to resource the increased and ever urgent demands for an accurate taxonomic picture of our flowering and lower plants, as well as their own programmes for imparting current knowledge on the flora? The two Proteaceae volumes are fortunately based largely on revisional studies. However, of concern is the potential compromise of this revisional base through lack of resources. It is therefore unfortunate then that the prime source of external funds for revisional work is being directed more and more towards taxonomic work constrained to serving the completion of a first edition of the *Flora of Australia* within a foreseeable time. The resourcing of increased revisional research in the Australian flora needs to be addressed urgently. Revisions have produced substantial changes to concepts presented in our national and regional floras in recent decades. Valuable as a broad overview of the Australian flora is, the quality demanded of many decisions being made on the Australian environment increasingly falls short through lack of in-depth taxonomic knowledge potentially attainable for many plant groups.

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Names

New names and combinations are in **bold**. Synonyms, misapplied, misspelt, illegitimate or invalid names are in *italics*.

Page numbers

Page numbers in **bold** refer to the main taxonomic treatment. Page numbers asterisked (*) refer to figures and maps.